

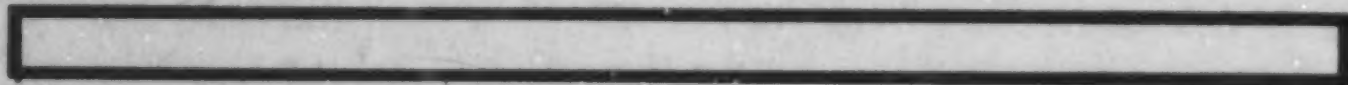
**A Land Use Analysis of Existing and Potential
Coal Surface Mining Areas in the Ohio River
Basin Energy Study Region**

**Ohio River Basin Energy Study
Urbana, IL**

Prepared for

**Environmental Protection Agency
Washington, DC**

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A LAND USE ANALYSIS
OF EXISTING AND POTENTIAL
COAL SURFACE MINING AREAS IN THE
OHIO RIVER BASIN ENERGY STUDY REGION

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FOREWORD

The Ohio River Basin Energy Study (ORBES) is an interdisciplinary, multi-university inquiry into the environmental, economic, and social impacts of energy facility development in a major portion of the Ohio River Basin. The study was initiated by the U.S. Environmental Protection Agency in 1976 in response to a directive from the U.S. Senate Appropriations Committee.

Most of the ORBES research was conducted by a group of faculty members at the University of Illinois, Indiana University, the University of Kentucky, the University of Louisville, The Ohio State University, the University of Pittsburgh, Purdue University, and West Virginia University. In a few instances, the necessary expertise was found at other universities or independent research organizations.

This report is one of a series produced in support of the overall ORBES assessment. For a summary of the entire study, see Ohio River Basin Energy Study (ORBES): Main Report, by the ORBES Core Team, also being published by the U.S. Environmental Protection Agency.

ABSTRACT

The land use changes resulting from the surface mining of coal in the Ohio River Basin depend on the distribution of the coal, the economic attractiveness of the coal, demand, rigor and effectiveness of regulatory mechanisms, and the resilience of the existing ecosystems. This study assumes three levels of coal demand taken from ORBES scenarios. The study analyzes existing industrial and governmental data on distribution, availability, and extraction of strippable coal. The history of reclamation enforcement and compliance is examined and several potential land use results of the Federal Surface Mining Control and Reclamation Act of 1977 are analyzed. All of these factors are compared to existing patterns of topography, agriculture, and forestry. Results indicate that surface disruption per ton of coal is greater in the Appalachian Basin than in the Eastern Interior Basin. Further, restoration as a result of reclamation appears to occur on the average more rapidly and cheaply in the Eastern Interior Basin because farmland uses, most common in the Eastern Interior Basin, are also more adaptive to quick restoration than is the forest cover typical of the Appalachian Basin. The various scenarios when compared show little difference in Ohio Basin wide impacts. However, each scenario supports a pattern of significant variation from state to state as a result of differences in topography and land use.

This report was submitted in fulfillment of a subcontract to Indiana University under Prime Contract EPA R805588010 between the University of Illinois and the U. S. Environmental Protection Agency. This report covers the period 1 January 1978 to 31 July 1979 with all research completed as of 30 November 1979 and the semi-final draft completed as of 30 April 1980.

PREFACE

This study was designed to provide the ORBES Core Team with information on existing and potential impacts of surface mining on land use. The general reader will find that historical facts and our interpretation of federal surface mine regulation are largely self-contained. Other issues, particularly those dealing with the future, draw heavily from other ORBES work and should be best understood with concurrent consultation with other ORBES reports, particularly the Ohio River Basin Energy Study (ORBES): Main Report.

As a cautionary note, however, a few of our assumptions deviate from those of other ORBES work slightly, and our analyses of ORBES Scenarios are limited to four. These factors result from differences in the official time frames between our research and certain other aspects of ORBES work. Our main research phase concluded July 31, 1979 with small modifications being made to November 30, 1979. Our assumptions differ from those of some other ORBES reports as follows:

- 1) We refer to low sulfur coal as having 1% sulfur or less as opposed to 1.8% or less. This difference does not modify our scenario work.
- 2) We designated a portion of our utility coal as originating in counties with major surface reserves. All coal to be used by future power plants, however, corresponds to coal assignments elsewhere in ORBES work.

A number of people provided substantial assistance in producing this report.

Susan Eggert assumed the major responsibility of compiling data on surface mine production and affected acreages for the various counties. Margaret Cockburn extracted a portion of the data needed from surface mining permits in Ohio.

Craig Caupp and Joel Wagner assisted in the field by collecting data during visits to 35 sites. Caupp also contributed to the literature search and Wagner provided a portion of the graphics.

Virginia Gleason of the Bituminous Coal Research Institute provided valuable library assistance. Walt Hausemeuler of the Indiana Geological Survey furnished information on coal production. Don Blome of the University of Kentucky Institute for Mining and Mineral Research served as a valuable consultant at various points during the project. We thank William W. Oliver of the Indiana University Law School for arranging a

visit to an active surface mine. Gary Fowler and Steve Jansen of the University of Illinois at Chicago Circle made computer production of several of our figures possible.

Ann McMillan edited several of the drafts of this report. The following persons typed portions of one or more drafts: Stephanie Collins, Carolyn Douglas, Carla Laymon, Judy Perkins, Sheila Lewis, Becky Miller, Jolane Moneyhun. Cathy Partenheimer typed the final draft.

The authors assume responsibility for any mistakes which may remain.

CONTENTS

Abstract	iv
Preface	v
Contents	vii
Technical Report	1
1. Introduction.	1
2. Coal Mining Areas of the ORBES Region	3
3. State Regulation of Surface Mining.	5
Historical Development of Surface Mining Activity	5
Historical Facts about State Surface Mining Regulation.	7
Evidence Concerning the Success of State Regulations.	7
4. Possible Impacts of Federal Surface Mine Regulation on Lane Use	15
Introduction.	15
Federal Regulatory Scheme	15
Regrading	17
Revegetation.	18
Prime Farmland.	19
Steep Slope Mining and Mountaintop Removal.	20
Response of the Coal Industry	22
Legal Footnotes and References.	28
5. Quantitative Data on Coal Reserves and Mining Activity.	35
Mineable Coal Reserves.	35
History of Surface Mine Production.	35
Recent Surface Production	39
Geographical Relationships Between Strippable Reserves and Surface Mining Activity	39
Total Affected Acreage by County.	42
Coal Refuse Areas	44
Land Area Requirements for Surface Mine Production.	44
6. Surface Land Use in the Regions of Surface-Mining Activity and Potential	51
Introduction.	51
Agriculture	51
Forestry.	54
7. Quantitative Land Classification.	55
Introduction.	55
Land Capability Class 1	55
Land Capability Classes 7 and 8	55
Flat Lands: 0.25% Slope.	58
Steep Slope Lands: >25%, >30% Slope Depending on State	58

8. Application of ORBES Scenarios: Future Coal Production for All Purposes.	61
Introduction.	61
Ratios of Surface to Underground Mining	62
Ratios of Land Area to Production	64
Land Area Affected by Total Surface Production.	64
9. Application of ORBES Scenarios: Coal Production for ORBES Scenarios	
Power Plants.	66
Introduction.	66
Affected Lands.	71
Interactions between Surface Mining, Prime Farmlands, and Steep Slopes.	71
10. Capsul Review of Past and Present Reclamation	84
Introduction.	84
Quality of the Data	84
Lands Mined Prior to 1977	85
Changes in Land Use Resulting from Surface Mining	97
Rates of Recovery	97
Agricultural Productivity	100
Visits to Field Sites	103
Reclamation in the Future	111
Summary	114
Literature Cited	116
Personal Communications	125

1. INTRODUCTION

Coal constitutes the fuel for 90% of electrical generation in Illinois, Indiana, Ohio, Kentucky, West Virginia and Western Pennsylvania (Page, 1979). Future development will continue this trend. Electrical growth rate has slowed during the past decade and environmental regulation has shifted emphasis to lower sulfur western coals. However, the widespread use of scrubbers and development of synthetic fuel from coal in the east and an increasing demand for other uses for water in the west can reverse this trend.

Only 18% of the ORBES strippable reserves have been mined, but this has affected more than 1,600,000 acres (2,500 square miles, 1.3% of the ORBES region). At least 4,000,000 acres (3.3%) of the ORBES region are underlain with strippable coal. The surface conditions above the coal, economic value of the coal and the regulatory practices in various portions of the region all vary. Thus, we considered all three in this paper. Because all three are uncertain we applied several ORBES scenarios to predict high, low and moderate results. The scenarios were not picked as being particularly likely but rather to show the limits of potential impact.

Throughout this report we are concerned with both the changes in land use and the amount of time land is unavailable for any useful purpose. These depend on coal demand by location, the effectiveness of the regulatory process and the ecological capability of the land to recover. Each of these is interrelated and is carried through the entire paper. All three contain some inherent uncertainty as well. A particular regulation may change the economics of coal in a certain area so that it becomes profitable enough to reclaim after mining. Similarly, the ecological capability affects the reclamation costs. Graphically, the interrelation seems straight forward (Figure 1-1). Demand for coal generally or for a particular coal may increase seam value. This would be the logical trend with an increased demand for electrical utility energy. Thus, with more value there can follow higher customer charges and more gross proceeds to spend on reclamation.

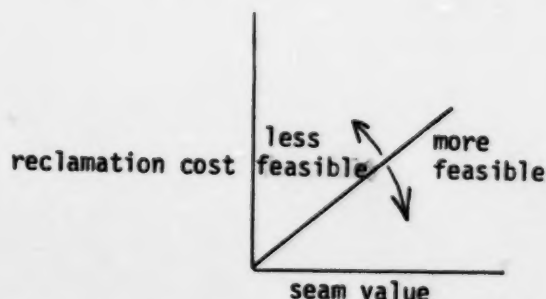


Figure 1-1. Seam Value vs. Reclamation Cost

Either new technology or weaker requirements may reduce recovery costs. Ecological capability is more fixed and dependent on location. Thus, we developed the following objectives:

Objectives

- A. Summarize the available literature on land involvement in surface mining in the ORBES region, reclamation practices and successes, ecosystems present on such lands, and their use by people.
- B. Conduct field work to evaluate the accuracy of the literature and to complete our information in poorly documented areas.
- C. Examine and compare the success of the regulatory processes for surface mine reclamation in each ORBES state, and predict the pattern of regulation under the Federal Surface Mining Control and Reclamation Act of 1977 (SMCRA).
- D. Develop a method to integrate historic influences on land use with potential impacts of the SMCRA and the ORBES scenarios.
- E. Apply the method using scenarios which have high, moderate and low coal demand to evaluate future trends in land use.
- F. Report this study to the ORBES Core Team.

At this writing (January, 1980), the relation of state processes and the Federal SMCRA are very unclear and changing rapidly. In the last week, January 13-20, the Office of Surface Mining temporarily withdrew some of the new regulations dealing with exempting some operators from restoring Prime Farmland and bonding. OSM is being challenged in court by operators such as Peabody Coal Company and environmental groups such as the National Wildlife Federation. Our findings are sensitive to the outcome of these negotiations.

2. COAL MINING AREAS OF THE ORBES REGION

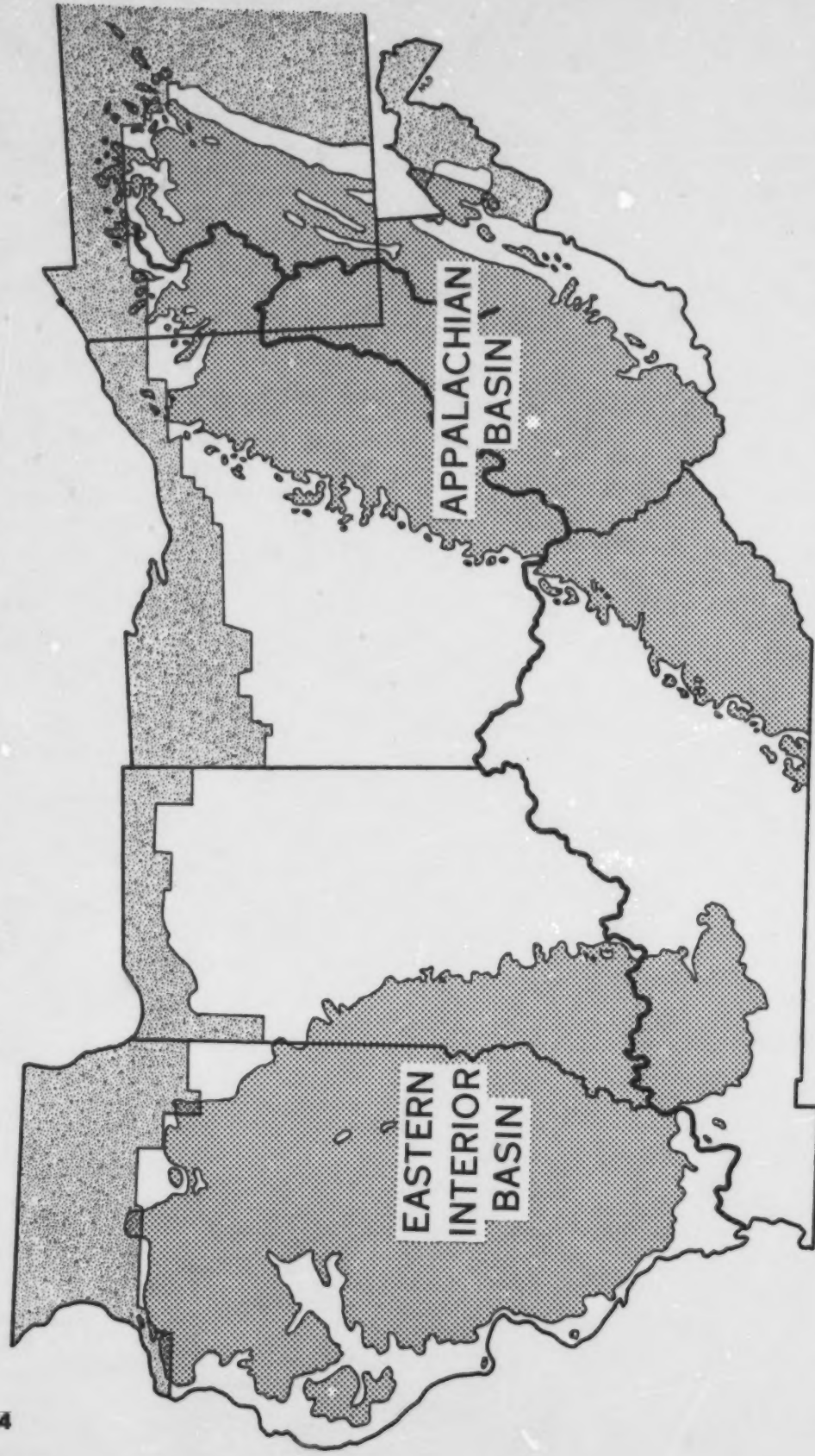
Coal resources are distributed unevenly throughout the ORBES region. These irregularities greatly affect the location of potential changes in land use. Data on reserves can imply where mining may occur; data on production indicate where various levels of activity have occurred. Naturally, we can expect to find effects upon land use where mining has occurred, is about to occur, or will occur eventually.

Within the ORBES region lie portions of two geographically separated coal fields, the Eastern Interior Basin and the Appalachian Basin (Figure 2-1). The coal in both basins is entirely bituminous in form, with heating values ranging from 10,500 to 14,000 btu's per pound. Commercially valuable seams with a high percentage of fixed carbon become more abundant from west to east, and are most abundant in eastern West Virginia and Eastern Kentucky.

OHIO RIVER BASIN ENERGY STUDY PHASE II

Figure 2-1

ORBES COAL FIELDS



Source : Adapted From COAL FIELDS of the UNITED STATES by James Trumbull, 1960.

3. STATE REGULATION OF SURFACE MINING¹

Laws become weak without a system of enforcement to back them. The Federal Surface Mining Control and Reclamation Act of 1977 (SMCRA) is more restrictive than pre-existing state laws, that is, more insistant on complete reclamation to the original topography. Not only do states have their own regulations but also their own enforcement agencies, and rigor of the law and the rigor of compliance may vary. We recognize that adequate reclamation may not follow future mining activity throughout the ORBES region. In using the past as an indicator of the future, three features of importance include the history of mining activity, the history of state legislation and evidence of compliance or noncompliance with state law.

Historical Development of Surface Mining Activity

Surface mining developed gradually throughout the ORBES region. In the early 1900's, production was generally so low and scattered that much of the mined tonnage may not have been recorded. For instance, the date when any state produced its first million tons is probably unknown. In most states annual rates of production rose steadily, and by 1922 the U.S. Bureau of Mines was publishing annual reports of surface mine production in its Minerals Yearbook series. Except for West Virginia, which experienced a decline in surface mine production during the 1930's, production in the other states continued to increase into the mid-1940's as did the demand for coal and technological advances in mining equipment.

Table 3-1 lists dates marking cumulative production of the first 10 and 100 million tons of surface-mined coal in the ORBES portions of the states. The dates marking production of 10 million tons may be a few years behind the actual year due to the aforementioned lags in record keeping. By the time 100 million tons were produced, annual increments were so large that the listed years are either correct or within one year of the actual year. It is clear that Illinois and Indiana have relatively long histories of surface mine production while Ohio and Pennsylvania follow closely. Kentucky-East is a newcomer, where dramatic increases in production have occurred during the 1960's.

¹This section was completed in July, 1979.

Table 3-1

Dates Marking 10 Million and 100 Million Tons of
Cumulative Surface Mine Production

State	Eastern Mid-Continental Basin			Appalachian Basin		
	Date	10 Million Tons	Years B.P. ²	Date	10 Million Tons	Years B.P. ²
Illinois ³	1925		55			
Indiana	1923		57			
Kentucky - West	1946		37			
				State		
				Kentucky - East		
				Ohio		
				Pennsylvania ³		
				West Virginia ³		
				Date	10 Million Tons	Years B.P. ²
				1939		41
				1939		41
				1954		26
				1951		29
				1920		60
				1926		54
				1943		37
				1968		12
				1945		35
				1945		35
				1949		31

¹Sources for computation: Illinois Department of Mines and Minerals, 1955; Indiana, Pennsylvania, West Virginia, U. S. Department of Interior, Bureau of Mines, Minerals Yearbooks, for 1915-1975; Kentucky, Currans and Smith, 1977; Ohio Department of Natural Resources, 1956.

²Years before 1980.

³ORBES counties only.

Counties which stand out as having a long and productive history of surface mining include Fulton and Perry Counties, Illinois; Pike and Warrick Counties, Indiana; Muhlenberg County, Kentucky; Belmont, Jefferson and Harrison Counties, Ohio; and Clarion and Washington Counties, Pennsylvania.

The structure of the mining industry differs from state to state and region to region (Walls et al., 1979). Table 3-2 reflects these differences in terms of the numbers of surface-mining permits issued for large vs. small mining operations. In the last decade all states have required all significant operations to have permits. The greatest contrast occurs between Illinois and Indiana, where large mines equal or outnumber small mines, and eastern Kentucky and Pennsylvania, where small mines outnumber large mines. For enforcement purposes eastern Kentucky and Pennsylvania, in contrast to Illinois and Indiana, would require greater facilities due to their ten-fold greater number of permits and operations.

Historical Facts about State Surface Mining Regulation

Regulatory programs have varied from state to state (Table 3-3). Clearly, some states took 20 years longer than others to pass any form of reclamation law at all, and the lags did not correspond to surface-mining activity (e.g., Illinois vs. Pennsylvania). However, for eight or more years, all states have had laws aimed at significant restoration of mined lands. This capability has included preparation of a pre-mining reclamation plan. Thus, the ORBES states have the experience for understanding the federal law and complying with it both within the state regulatory agencies and the mining industry.

Five of the six states permitted an option in which operators could elect to reclaim a disturbed parcel of land other than the one which they had mined. For such an option there had to be an abundance of orphaned, unreclaimed land available, as often was the case. Table 3-4 indicates that this option remained effective for about 20 years in four of the six states. A major argument favoring the option was that spoils from recently mined land needed several years of weathering before vegetation could grow on them. But it had negative aspects. The operators did not mine and prepare land to facilitate reclamation. Responsibility for a particular piece of land was obscured, and land which was most difficult to reclaim tended to remain unreclaimed. Some agency files were such that an outsider could have a difficult time determining responsibility for a given piece of land.

Evidence Concerning the Success of State Regulations

Successful reclamation can be defined two ways. Were the laws satisfied? Or, was the land reclaimed? On the one hand the law may be enforced but rules are loose and the product tends to be shoddy; on the other, the law may be stringent but unenforced. Table 3-5 concerns these issues. This table in-

cludes the relative amount of recent mining activity, the percentage of land covered by law and adequately reclaimed, and a ratio of citations to permits. The first index is Column #4 which is the ratio of Column #3 to Column #2. If considerable mining activity is recent, much land covered by law may be legally unreclaimed due to insufficient time for reclamation. If little mining activity is recent, much of the acreages should be reclaimed but possibly under lax versions of the law.

In Column #5, "Reclamation Ratio," a high ratio indicates that either (1) most land legally requiring reclamation has been reclaimed according to law, or (2) that recent mining activity is so little that the acreage requiring reclamation is so trivial as to be overshadowed by natural, voluntary, and compliance reclamation occurring over many years. A low ratio may mean poor legal standards, non-compliance or a large amount of recently mined acres in the process of being legally reclaimed.

Columns #4 and #5 taken in conjunction, narrow the possibilities. The figures for Indiana suggest an early history in which less attention was paid to reclamation. The figures for eastern Kentucky suggest that recent disturbance may be an important factor; Kentucky's law may be effective and working. In West Virginia reclamation appears to be succeeding much better than in Indiana. The first laws in both states are about equally old. However, West Virginia never had an alternative lands option for reclamation. Finally, the SCS standards (that is, our source) may differ slightly (due to natural topographic contrasts, Figures 7-3 and 7-4), in which case the observer is not impartial.

Columns #6, #7 and #8 concern enforcement. Citation rate (Column #8) varies from state to state. It is possible that law enforcement was not equal among the states for the period covered. However, alternative explanations are (1) that the type of violation requiring a citation varies from one state to the next, or (2) that the surface-mining industry is more educated in some states than in others. If we assume that medium to large mine operators are more experienced and have more technical resources than small operators, then the low citation rates in Illinois and possibly Indiana may be explained by operator experience.

Table 3-2

Numbers of Surface Mining Permits and Mines

	<u>Approximate Number of Permits Issued Annually¹</u>	<u>Number of Surface Mines in 1975²</u>		
		<u>Total</u>	<u>Large Mines (>500,000 tons)</u>	<u>Small Mines (<10,000 tons)</u>
Eastern Interior				
Illinois	40 ³	374	18	3
Indiana	150	60	13	13
Kentucky-West	170	155	17	51
Appalachian				
Kentucky-East	930	1,350	6	527
Ohio	450 ³	315	11	64
Pennsylvania	1,100	703	7	213
West Virginia	250	369	2	79

¹Sources of permit data: Illinois Department of Mines and Minerals, 1976-1978 (Annual Reports, Surface-Mined Land Conservation and Reclamation); Indiana Department of Natural Resources, unpublished data; Kentucky Department of Natural Resources and Environmental Protection, computer printout of permit data; Ohio Department of Natural Resources, tally of permit files; Pennsylvania Department of Environmental Resources, Richard R. Thompson, personal communication; West Virginia Department of Natural Resources, unpublished data.

²Source: U. S. Department of Interior, Bureau of Mines, Minerals Yearbook for 1975.

³These permits may include numerous amended acreages in addition to the original acreage permitted.

⁴The number of mine locations is about 70.

Table 3-3

Surface Mining Regulatory History By State¹

STATE	FIRST REGULATORY ACT	PERMIT AND BONDING REQUIREMENT	INITIAL GRADING REQUIREMENT (STRIKE-OFF)	EXTENSIVE ² GRADING REQUIREMENT	PREMINING RECLAMATION PLAN PREREQUISITE TO PERMIT
ILLINOIS	1962 ³	1962 ⁴	1962 ⁵	1971 ⁶	1971 ⁷
INDIANA	1941 ⁸	1941 ⁹	1951 ¹⁰	1968 ¹¹	1968 ¹²
KENTUCKY	1954 ¹³	1954 ¹⁴	1954 ¹⁵	1964 ¹⁶	1964 ¹⁷
OHIO	1948 ¹⁸	1948 ¹⁹	1948 ²⁰	1949 ²¹	1965 ²²
PENNSYLVANIA	1945 ²³	1945 ²⁴	1945 ²⁵	1953 ²⁶	1963 ²⁷
WEST VIRGINIA	1939 ²⁸	1939 ²⁹	1945 ³⁰	1963 ³¹	1967 ³²

¹ All dates are effective dates of the specific legislative acts.

² Extensive grading includes grading to rolling topography, original contour or any reduction of spoil pile peaks and ridges that is not characterized as "strike-off."

³ Open Cut Land Reclamation Act, 1961 Ill. Acts. Effective January 1, 1962.

⁴ IBID., §1(4) made a permit necessary for surface mining in Illinois. §8 required a \$200 per acre bond (\$1,000 minimum) as a prerequisite for the permit.

⁵ IBID., §6(a) required grading to rolling topography adjacent to public highways. Elsewhere, spoil piles would be struck off to make a plateau not less than 10' wide (pasture) or cropland grading capable of being transversed by farm machinery.

⁶ Surface-Mined Land Conservation and Reclamation Act, 1971 Ill. Acts. §6(a) required grading to a rolling topography with slopes no more than 15% grade unless the post-mining land use mandates more slope. However, no slope will be required to be greater than 30% or less than original grade. Effective September 17, 1971.

⁷ IBID., §5(e) 14

- 8 1941 Ind. Acts, Chapter 68. Effective February 28, 1941.
- 9 IBID., §3 required surface mining operators in Indiana to have a permit. §7 required a bond of \$25 per acre (\$125 minimum) as a prerequisite for permit.
- 10 1951 Ind. Acts, Chapter 129 §4(b). Operator shall work any unsightly ridges by striking off to 8' width. Any isolated peaks shall be struck off to a minimum of 15'. Effective July 1, 1951.
- 11 1967 Ind. Acts, Chapter 344 §6(a). Operators were required to reduce peaks and ridges and diminish depressions to a rolling topography. Effective January 1, 1968.
- 12 IBID., §5(b) (vii).
- 13 1954 Ky. Acts, Chapter 8. Effective July 1, 1954.
- 14 IBID., §6(1) made permits necessary for surface mining. §6(4) required a bond between \$100-250 per acre.
- 15 IBID., §9(5) required operators to "grade spoil banks" with no further elaboration of the requirements.
- 16 1964 Ky. Acts, Chapter 61 §4(1)(e) required grading to a "rolling topography to be defined by regulation." Effective March 19, 1964.
- 17 IBID., §3(4).
- 18 Strip Coal Mining Act, 1947 Ohio Laws. Effective January 1, 1948.
- 19 IBID., §4 requires a permit to surface mine in Ohio. §5 requires a \$100 bond per acre (\$1,000 minimum).
- 20 IBID., §4 also requires that the operator strike off spoil piles to a width of 15'.
- 21 Coal Strip Mine Land Reclamation Act, 1949-1950 Ohio Laws. §898-232(A) requires the operator to grade surface of spoil banks to gently rolling topography. Any isolated peaks must be graded to a level surface with a width of at least 20'. Effective July 23, 1949.
- 22 1965 Ohio Laws. Effective August 19, 1965.
- 23 Bituminous Coal Open Pit Mining Conservation Act, 1945 Pa. Laws. Effective May 31, 1945.
- 24 IBID., §1 requires both permit and bond of \$200 per acre (minimum \$2,000).
- 25 IBID., §10 requires that peaks and ridges of spoil banks be leveled and rounded off to permit planting of vegetation.

- 26 1953 Pa. Laws. §5 requires operator to backfill to 15' of public highway right of way boundary and provide lateral support at an angle not greater than 40°. Effective August 19, 1953.
- 27 1963 Pa. Laws. Effective July 16, 1963.
- 28 1939 W. Va. Acts, Chapter 84. Effective June 11, 1939.
- 29 IBID., §1 requires a permit and bond of \$150 per acre (no minimum amount).
- 30 1945 W. Va. Acts. Chapter 85 §4(5) requires regrading overburden so as to refill any ditches and trenches. Effective March 10, 1945.
- 31 1963 W. Va. Acts. Chapter 139 §2(a) requires grading to a rolling topography and minimizing the number of large rocks. Effective July 1, 1963.
- 32 1967 W. Va. Acts, Chapter 45 §20-6-9. Effective July 1, 1967.

Table 3-4

Alternative Land Reclamation Option

<u>STATE</u>	<u>Starting Date</u> ¹	<u>Ending Date</u> ²	<u>Duration</u>
ILLINOIS	January 1, 1962 ³	September 16, 1971	9 yrs., 9 months
INDIANA	February 28, 1941 ⁴	December 31, 1967	26 years, 10 months
KENTUCKY	June 1, 1954 ⁵	August 2, 1977 ⁶	23 years, 2 months
OHIO	January 1, 1948 ⁷	April 9, 1972	24 years, 3 months
PENNSYLVANIA	May 31, 1945 ⁸	December 31, 1964	18 years, 7 months
WEST VIRGINIA	none	none	none

¹Effective date of state law providing for alternative land reclamation option.

²Last effective date for state law containing this option.

³Open Cut Land Reclamation Act, 1961 Ill. Acts.

⁴1941 Ind. Acts, Chapter 68.

⁵1954 Ky. Acts, Chapter 8.

⁶SMCRA became effective on August 3, 1977.

⁷1947 Ohio Laws.

⁸1945 Pa. Laws.

Table 3-5

Indicators of the Success of the State Reclamation Laws

State	Acres of Historical Total Land Affected ¹	Acres of Recent Land Affected (1971-1976) ²	Recent as a % of Historical Total ³	Reclamation Ratio (%) ^{1, 4}	Annual Number of Operations or Permits Issued ^{5, 6} (1969-1972)	Average Number of Annual Citations For Non-Compliance (1969-1972) ^{5, 6}	Ratio: Citations to Permits (%) ^{7, 8}
IL	240,707	28,231	12	66	40	1.8	4
IN	156,055	22,663	14	43	40	2.3	6
KY-W	124,983	27,215	22	79	875	342	39
KY-E	284,609	87,014	31	35			
OH	438,329	70,703	16	68	178	35	20
PA	386,370	---	--	79	560	3,033	542
WV	228,027	39,849	17	95	401	118	29

¹Adapted to ORBES Region from U.S.D.A. Soil Conservation Service, 1979.

²References listed with Table 5-4.

³Provides an index of recent vs. old mining activity. If considerable mining activity is recent, much land covered by law may be legally unreclaimed due to insufficient time for reclamation.

⁴Ratio of all reclaimed land to this same land plus lands mined under law and still needing reclamation in this and the preceding column suggests non-compliance, lax enforcement, or lax legislation.

⁵Source: Council on Environmental Quality, 1973.

⁶The form of measure is not identical from state to state; however, comparisons are strongly suggestive.

⁷Adapted from Council on Environmental Quality, 1973.

⁸High ratios suggest strong law enforcement effort; low ratios suggest either good compliance or lax enforcement.

4. POSSIBLE IMPACTS OF FEDERAL SURFACE MINE REGULATION ON LAND USE¹

Introduction

The purpose of this section is to analyze the impacts of the Surface Mining Control and Reclamation Act of 1977 (SMCRA) on post-mining land use in the ORBES region. This analysis will not attempt to evaluate the numerous specific provisions of the Act, but will focus on five aspects of the surface-mining process that can directly affect post-mining land use and are subject to regulatory control. These aspects include regrading and revegetation requirements, provisions for mining on prime farmland, and the special regulations for Steep Slope Mining and Mountaintop Removal. [Note: Because this chapter deals extensively with legislative issues, documentation follows a legal style and appears at the end of this chapter, not in Literature Cited or Personal Communications.]

Federal Regulatory Scheme

The implications for land use of these aspects would be meaningless without an overall view of the SMCRA scheme for regulating surface mining and reclamation. Congress intended to ensure that the objectives of environmental protection and reclamation are co-equal with the objective of producing coal. To implement these primary objectives, SMCRA set up the Office of Surface Mining Reclamation and Enforcement (OSM) within the Department of the Interior to administer a two-phase program for surface mine regulations. Under the initial phase, OSM formulated interim regulations to be generally effective in all states that are regulating some aspect of surface mining on the effective date of the Act. These interim regulations have been effective since February 3, 1978, for all new surface mine operations and since May 3, 1978, for pre-existing operations. These regulations did not implement the SMCRA permit system and only required compliance with eight of the general performance standards.

As part of the second phase, OSM has developed regulations for a permanent federal regulatory scheme in the event that any state does not exercise its option to develop a state regulatory program. If a state does implement its own plan, the permanent regulations function as minimal guidelines.

¹Completed in July, 1979 and not revised since then.

The federal regulations discussed in this analysis are the Final Rules for the Permanent Regulatory Program.⁶ Unlike the interim regulations, these Final Rules incorporate all of the performance standards required by SMCRA.⁷

Within the SMCRA regulatory scheme, the responsibilities for land use by surface mined areas are left to the states, subject to meeting certain federal minimum requirements, unless the state is unwilling or unable to assume these responsibilities on its own initiative. Careful reading of SMCRA and subsequent OSM regulations indicates a large degree of federal control of state programs. This control has caused concern on the part of the coal operators that "...procedural requirements for state programs signal a drift away from the strip mine law's state lead concept"⁸ and live up to the coal industry's comment that "the federal formula is not workable in the fifty states and the prohibitory provisions coupled with the invitation for unlimited litigation and the opportunity for bureaucratic stagnation will seriously impair the industries' ability to provide increased coal production."⁹

In order to be approved by OSM, all state laws and regulations must be "consistent" with SMCRA where consistency is defined as "no less stringent than, meet the minimum requirements of and include all applicable provisions of the Act."¹⁰ These minimum standards can be viewed as providing long needed uniformity in state regulations or, conversely, as one of the first massive federal intrusions into state and local land use planning.¹¹

With this general overview of the federal regulatory scheme in mind, we will discuss each of the five selected regulatory provisions. These provisions will be discussed with respect to their possible effects on land use in light of field observations of past reclamation efforts, statements made by the coal industry, and a knowledge of the ORBES state's regulatory history.

Any actual changes in land use will be the result of enforcement of the Final Rules by OSM under a federal program or state enforcement of state law based on the Final Rules. Enforcement will play a key role in realizing these changes in a consistent manner throughout the ORBES region. Consistent regional enforcement will be significant since the ORBES states fall into three different OSM regions.¹² Because an assessment of the capability of enforcement state-by-state is beyond the scope of this analysis, we assume uniform enforcement of the regulations as written. This assumption is contrary both to the known realities of bureaucratic enforcement and to the flexibility in enforcement stressed by both OSM¹³ and the coal industry.¹⁴ The potential changes in land use under a strict regulatory scheme may underscore the need for flexibility in federal enforcement and for state involvement in program planning and maintenance.

Regrading

The past 30-year history of grading requirements among the ORBES states demonstrates a progression from minimal grading requirements of striking off spoil ridgetops to the extensive backfilling, compacting, and grading necessary to achieve "approximate original contour" under the Final Regulations¹⁵ and under some pre-SMCRA state programs (Table 3-3). This grading requirement is an extremely important factor in influencing post-mining land use.¹⁶ Field observations indicate a positive correlation between requirements for grading to original contour and production of hay and alfalfa on reclaimed lands. In some states this result is partially due to the requirement for "quick cover" that hay and grass provide. However, it is expensive to move the earth¹⁷ and achieve original contour, and any immediate capital return on regraded land prior to bond release would be favorable to operators. If regraded land is sown with wheat the first year, alfalfa and yellow sweet clover the next year, the operator has fulfilled grading and quick cover requirements in addition to harvesting wheat and hay for sale within two years after mining (see also Chapter 10).¹⁸

As a result of regrading expense and the increased cost of land,¹⁹ many coal companies retain the land after mining and manage it for grazing and agricultural purposes. While short term leasing of the mineral rights is often the rule in many states, i.e. Indiana, land retention by the operator is becoming more common. In some cases the land management company is a subsidiary,²⁰ but this phenomenon is no longer limited to large operations. Many small companies also manage or maintain the reclaimed land for the available economic return.²¹

The greatest disadvantage of grading to the requirement of original contour is that it limits the post-mining land use to uses possible prior to mining; that is, it decreases diversity of post-mining land use. While this requirement insures that the surface mined land will blend into the surrounding area after mining has ceased, the value of post mining land is often contingent on its unique characteristics of water and topography that are the result of mining.²² For example, the stripped area around the Coal City Club in Coal City, Illinois, consists of ungraded mounds of spoil interspersed with areas of water which contrast distinctly with the surrounding flat Illinois prairie. The area is the subject of a multi-million dollar recreational housing development that is utilized by residents of the Chicago area 60 miles away.²³ Under the requirements for grading to original contour this use would not be feasible. In fact, the area would be reclaimed to a plain typical of Illinois (see also Chapter 10).

The requirement of grading to original contour effectively eliminates some reserves from being mined, particularly reserves under certain steep slopes where grading to original contour or mountaintop removal is not possible or economically feasible. The extent to which reserves minable

according to pre-law criteria are affected by this grading requirement has not been determined. However, considering the large strippable coal reserves located in the steep terrain of Eastern Kentucky and West Virginia, the reservation may be significant.

Summary: Strict adherence to the original contour grading requirement will have the following land use changes:

1. Increased hay and pasture land uses on surface-mined land.
2. Decrease in diversity of post-mining land use and emphasis on hay and pasture uses.
3. Some increase in coal company management of land after mining.
4. Possible reduction in strippable reserves that can be mined in accordance with federal law.

Revegetation

SMCRA Environmental Protection Performance Standards²⁴ affect revegetation of surface-mined land in two ways: first, by determining the type of vegetation to be used and second, by requiring success in the revegetation process. The vegetation must be diverse, permanent, and capable of self-regeneration.²⁵ In addition to these criteria, the vegetative cover must be successful five years after seeding and fertilizing has ceased.²⁶ Therefore, in revegetating a surface-mined area, the operator must not only be concerned with what type of cover is being planted, but whether that cover will be successful for the requisite five-year period. As a result of this requirement, the operator must maintain a long term interest in the land and its subsequent use.

The Permanent Regulations expand upon both of these basic requirements by requiring that all disturbed land shall be seeded or planted to achieve a vegetative cover of the same seasonal variety native to the area of disturbed land.²⁷ If the regulations had stopped there, these provisions would clearly decrease the diversity of land use by limiting revegetation to pre-mining communities. This could be a formidable task, given the inability of many surrounding communities to persist on recent post-mining land. However, "cover" is defined to be a "mixture of species having superior or equal utility in comparison to naturally occurring vegetation."²⁸

While this clarification allows for greater diversity in post-mining revegetated communities, the meaning of "utility" remains unclear. Utility may refer to market price after harvest or to usefulness in the ecological sense of slope stabilization or community stability. A strict "market price" interpretation could preclude the land from being suitable for mining. For

example, in the coal field of eastern Kentucky, surface mining is likely to take place on land with hardwoods, particularly oaks and hickories. Since it would be impossible to plant a typical hardwood forest immediately after mining, the alternatives for vegetative cover include some native grasses for haying or tree species such as black locust and Virginia pine, which are suitable for recently mined lands. The market value of these alternatives cannot measure up to the naturally occurring hardwood forest, and, under a "market place" interpretation, the requirements for revegetation could not be met. Clearly, some further guidelines are needed to allow for more diverse revegetation of surface mined lands.

Under the Final Regulations the success of the plantings will be determined by comparison to a reference area.²⁹ The revegetated area will be compared to an approved, unmined area for ground cover and productivity.³⁰ Unfortunately, this test fails to take into account the long term persistent differences between mined and unmined land that make comparisons of productivity difficult. The percent cover test is likely to give an adequate measure of the success of revegetation without emphasis on productivity.

Success is also contingent upon yearly observations over a five-year period following seeding and fertilizing. This particular requirement could have far-reaching consequences for post-mining land use, for as long as the operator must maintain a five year interest in the land, any reclamation method that results in some short term economic return is likely to be favored.³¹ This requirement may encourage continued fertilization, irrigation, and harvesting of the land by the operator to achieve some harvestable return.

This continued responsibility encourages subsidiary management (large operations) or retention of the land by the coal operators. Furthermore, the land use under these situations is likely to favor agricultural productivity (grazing and haying) with smaller acreages allocated to various other uses.

Summary: While the type of vegetation required by the Proposed Permanent Regulations encourages diverse use, the requirement for success does not. Together, the revegetation and regrading requirements reinforce the movement of surface-mined land into pasture and hay production and encourage long term operator use of the land.

Prime Farmland

Prime Farmland is a land classification based on pre-mining land use or on actual characteristics of the soil. If the pre-mined land is classified as Prime Farmland by the Secretary of Agriculture,³² it is subject to a unique set of regulations under SMCRA.³³ The goal of these regulations is reclamation to a level of equal productivity to unmined prime farmland within a

reasonable period of time. Although the feasibility of achieving "equal" productivity can be debated, it is clear that the regulations for prime farmland involve rigorous pre-mining treatment of the land. The soil is to be segregated by separate soil horizons, and these layers are to be replaced immediately or stored separately.³⁴ After mining and regrading to original contour, these horizons are to be replaced in natural sequence with precautions to avoid compacting.³⁵ This process of reconstruction of soil is both costly and time-consuming.

The State of Texas challenged the provisions of the soil segregation of prime farmland under the Federal Interim Regulations.³⁶ OSM ruled that mixing of soils would be permitted if a higher agricultural yield could be obtained after mining.³⁷ Other provisions concerning prime farmland have been the subject of litigation³⁸ and extensive comments from the coal industry.³⁹

These regulations effectively discourage mining operations on prime farmlands. The concern of industry over the scope of the grandfather exemption of prime farmlands in the original permit area or in an approved mining plan prior to August 3, 1973, is good evidence of this discouragement. Acres of potentially minable land will not be mined because of the difficult process of soil reconstruction and the goal of equal or higher productivity. These provisions are particularly relevant to the State of Illinois, where much of the coal is overlain with prime farmland soil.

As far as post-mining land use is concerned, "Prime Farmland" is automatically determined to be the highest and best use. Stringent regulations are set up to ensure that productive row crop agriculture is possible after mining. This determination leaves no latitude for development of alternative uses. The inflexibility of these provisions effectively ensures preservation of valuable prime farmland without an absolute ban on mining these lands.

Summary: The prime farmland provisions automatically designate agriculture as the highest and best use of the land. This restriction limits post-mining land use to agriculture and requires the operator to comply with rigid, costly soil reconstruction regulations to achieve high agricultural productivity. These regulations effectively increase the difficulty of mining and consequently decrease the likelihood that prime farmlands will be mined.

Steep Slope Mining and Mountaintop Removal

Steep Slope Mining and Mountaintop Removal are two types of mining operations which require special regulation under SMCRA. These operations are widely applicable to mining in the Appalachian Region. In recognition of the importance of the coal reserves and mining potential in this area, SMCRA

allows variance from the requirements of grading to original contour for these two operations.⁴⁰ This variation from standard grading requirements is tightly controlled in recognition of the many erosion and water quality problems that occur in conjunction with mining mountainous terrain.

The deviation for Steep Slope (greater than 20%) does not allow any of the highwall to remain exposed but does permit disturbance of unmined areas above the highwall, which is otherwise prohibited. Thus, while giving the appearance of relaxed standards, these regulations still limit or reduce steep slope mining because of the difficulty in covering the highwall or covering the highwall and still meeting the requirements for slope stability.⁴¹

The steep slope requirements also present numerous engineering difficulties.⁴² From an engineering standpoint, the requirements for a 1.3 static safety factor⁴³ and watershed control are difficult to meet and make the variance from grading to approximate original contour very difficult to obtain.⁴⁴ Therefore, these provisions generally operate to discourage steep slope mining and leave mountaintop removal as the only viable method to remove the coal.

Surface mining by Mountaintop Removal removes all overburden on top of the coal seam and replaces the steep mountaintop with a level plateau. This procedure is subject to special guidelines allowing variance from the requirements of grading to original contour.⁴⁵ This flexibility is important to the mountainous ORBES region, and particularly to the State of West Virginia, which takes great pride in its work with valley and head of hollow fills that are associated with mountaintop removal.⁴⁶ Unfortunately, the large capital costs for equipment to remove the overburden makes this type of operation very difficult for the small coal operator.

Operations of mountaintop removal and valley and head-of-hollow fills create flat land or rolling terrain which is extremely valuable in steep mountain and narrow valley regions. Currently, the West Virginia Department of Natural Resources has issued permits for two housing developments on mountaintop removal land.⁴⁷ Quite understandably, the mine operator can, and often does, speculate on the economic return from these areas. The mining operation can take land originally worth \$50-\$75/acre in surface rights and increase the value to \$1,500-\$2,000/acre after reclamation.⁴⁸ Ironically, the valley and head-of-hollow fills were not allowed under the proposed interim regulations.⁴⁹ However, OSM responded to suggestions from industry and revised regulations to allow this type of waste disposal and the type of post-mining land use associate with it.⁵⁰

The difficulty of steep slope mining, the high economic return on mountaintop removal operations and the availability of technology that can remove the tops of mountains, suggests the future growth of mountaintop removal

within the ORBES region. Mountaintop removal will result in commercial and residential land use near urban areas⁵¹ and further the trend toward pasture and agricultural use on the flattened land in more remote areas.

Summary: The federal requirement of regrading to original contour discourages contour mining on steep slopes. While the variance for steep slopes theoretically should allow more mining, operationally it does not. Mountaintop removal operations provide increased commercial and residential land use and could become the prevalent type of mining operation because of the high economic return on flat land in the mountains.

Response of the Coal Industry

"The coal industry is making every effort to bring surface mining operations into compliance with the goals and standards of SMCRA."

Robin Turner, Vice President, North American Coal Corporation⁵²

"Much of the industry has approached implementation of the Act in the same manner that they dealt with it while it was before Congress - they are fighting it tooth and nail."

Karl J. Englund, Director, Citizens Coal Project, Environmental Policy Institute⁵³

Somewhere between these two extreme viewpoints is the real response of the industry to SMCRA and OSM regulations. The controversy results from two opposing forces, the need for more production and the need to mine in an environmentally sound manner. Congress anticipated this problem and provided that production of coal and environmental protection are to be equal goals of SMCRA. However, the goal of environmental protection is costly in terms of both economics and delay. The impacts of delay on the consuming public are not yet well recognized.⁵⁴ The increased cost to the producers will ultimately be passed on to the consumers. Inasmuch as environmental constraints can often decrease production, industry sees an increase in the importance of environmental protection as a hindrance to the goal of increasing productivity.

This conflict has caused concern within the coal industry and has prompted challenges to OSM's interpretation of SMCRA at nearly every step of implementation. These challenges have been directed at both the interim and permanent regulatory program. An analysis of these challenges can help illustrate the difficulties facing the coal industry and the national program for regulating surface mining.

Interim Program: SMCRA required an active, viable interim program to be in operation within six months of the effective date of the Act.⁵⁵ New operators were required to comply with interim regulations by February 3, 1978 while all operations were to be in compliance by May 3, 1978.⁵⁶ These deadlines were complicated by the lack of adequate appropriations in implementing SMCRA⁵⁷ and Congressional delay in confirming Walter Heine as Director of OSM.⁵⁸ In the meantime, development of interim regulations was left up to a mining task force comprised of 80 persons borrowed from various Interior Agencies. These haphazard proceedings accentuated the coal industries' mounting concern: "Congress forced a yet-to-be formed agency with no official money and a staff detailed from other agencies to develop highly complex regulations in only 90 days that will have a massive impact on coal industry for many years to come. Allowing enough time for more careful review in developing regulations could have prevented many of the economic hardships, costly delays, and time-consuming litigation."⁵⁹

Despite these difficulties OSM published its proposed interim regulations on September 7, 1977.⁶⁰ After receiving comments from the public and the coal industry, the OSM's final rules for the interim regulatory program became available on December 13, 1977,⁶¹ nearly six weeks after the deadline set by SMCRA and only five months before the compliance deadline for all operations. Once these interim regulations were completed, OSM began to formulate the proposed rules for the permanent regulatory program.

In the meantime, the coal industry was disturbed over the requirements of the interim program. Charges of "bureaucratic overkill"⁶² and "the gospel of coal according to Big Brother"⁶³ prompted hearings in January, 1978 by the House Subcommittee on Energy and the Environment in exercise of the oversight jurisdiction. One of the major issues before the Subcommittee during the two-day hearings was extensions of SMCRA deadlines. The state of Kentucky called for a short term delay; Ben Lusk of the Mining and Reclamation Council of America wanted a six-month delay while National Independent Coal Operators Association asked for a nine-month to one year delay.⁶⁴ Despite the various pleas, Subcommittee Chairman Morris Udall decided it would be the best policy to "muddle through" the regulations and time constraints as they now exist.⁶⁵ As a final compromise, OSM issued extensions for submitting schedules for reconstruction of sediment ponds and related regulations.⁶⁶

In spite of these extended deadlines, the coal industry maintained that it was unable to fully comply with the interim regulations for the following four reasons: 1) OSM was six weeks late in issuing regulations, 2) Congress took six months to appropriate funds for OSM, which took even longer to become operational, 3) the lengthy UMW strike prevented any construction, and 4) extremely severe weather conditions added to construction delay.⁶⁷ However, OSM reported that despite these difficulties "most operators are planning to move ahead with complying with this Act."⁶⁸

Now that the interim regulations were on the way to becoming effective, technical issues presented by the rules became the source of controversy between OSM and the coal industry.

The five principal areas of controversy were control of sedimentation, provisions for blasting, Prime Farmlands, underground mining, and pre-existing structures.⁶⁹ As originally written, the provisions for control of sedimentation would eliminate many steep slope mining operations in Appalachia.⁷⁰ However, in dealing with these problem areas, OSM demonstrated flexibility in response to industrial concern by modifying these provisions in the revised interim regulations published February 27, 1978.⁷¹ In fact, the revised regulations drastically reduced the design criteria requirements for surface mine sedimentation ponds and temporary diversion structures, which allowed mining in West Virginia to continue essentially as normal.⁷² This example of agency-industry interaction indicates that reasonable compromises can be made to iron out technical difficulties.

The final focal point of industry's concern was the fate of small operators under the interim regulatory scheme. While small producers (annual production <100,000 tons) were given a limited exemption from all performance standards until January 1, 1979,⁷³ it is not clear that this exemption will suffice to allow these operators to stay in business. The problem is clearly stated by Ron Turner, Vice President of North American Coal: "We have brought the entire technical expertise of our company to bear on an interpretation of these regulations for several months. Even with this effort, we are not confident (1) we understand the problems and (2) we have the resources to meet the compliance deadlines. Small operators...are simply not going to be able to cope with massive and highly technical requirements set down in the regulations."⁷⁴

In early 1977 this controversy over the scope of the federal interim regulations erupted into court action by the coal industry. Surface Mining Regulation Litigation⁷⁵ was the result of 24 consolidated cases involving over 40 coal operators who attacked the interim regulations on both substantive and procedural grounds. The district court upheld most of the provisions of the interim regulatory scheme and denied a preliminary injunction blanket. However, regulations dealing with pre-existing nonconforming structures and facilities and the scope of grandfather exemptions covering prime farmlands were remanded to Secretary of Interior for further consideration. Regulations dealing with sedimentation ponds were enjoined until the Secretary responded to the industry's objections. Finally, regulations dealing with effluent limitations were enjoined to the extent that they conflict with Federal Water Pollution Control Act.⁷⁶ This opinion was affirmed by the Court of Appeals, on May 25, 1978.⁷⁷

On August 24, 1978, the district court issued its second and final review of the interim regulations after Interior's reconsideration of these regulations under the terms of the first district court decision.⁷⁸ The

court again instructed Interim to amend design criteria for valley and head-of-hollow fills, waste dam construction, and stream buffer zones. Interior was further enjoined from enforcing the "historical use" clause of prime farmlands section.⁷⁹ This decision is currently on appeal.⁸⁰

In the ORBES region there have been two cases filed in federal court in Indiana challenging the constitutionality of entire federal regulatory scheme.⁸¹ A coalition of Appalachian landowners have also filed suit in federal court in eastern Kentucky challenging the constitutionality of the approximate original contour provisions of SMCRA.⁸² In Virginia, the Virginia Surface Mining and Reclamation Association and others, including the Commonwealth of Virginia have also filed suit. In the only decision reported so far, U.S. District Judge Glen Williams of the Western District of Virginia enjoined nearly all of Title V of SMCRA on the grounds that the Act is a taking of property without due process of law and thereby violates the Fifth Amendment.⁸³ The outcome of these challenges will have important ramifications for the coal industry and the survival of the interim regulatory scheme.

Permanent Regulatory Program: At the same time that OSM has been involved in controversy over the Interim regulatory program it has been in the process of formulating regulations for the permanent regulatory program. Unlike the interim program, the final program interprets all of the Environmental Protection Standards and implement SMCRA permit process. The proposed permanent regulations were issued on September 18, 1978⁸⁴ and OSM invited public and coal industry comments at public hearings in six cities. The views of the coal industry were expressed by testimony from members of the National Coal Association/American Mining Congress Joint Surface Mining Committee.⁸⁵ The comments were sharply critical of OSM's short 60 day comment period,⁸⁶ provisions regulating alluvial valley floors,⁸⁷ the entire permanent regulatory program,⁸⁸ the lack of distinction between surface and underground mining,⁸⁹ and regulations on the disposal of excess spoil, coal waste banks and dams, and backfilling and grading.⁹⁰

OSM released a draft regulatory analysis shortly following the release of the proposed permanent regulations.⁹¹ The Joint Committee described this report as "an inadequate and misleading document...that failed to evaluate the impacts of the regulations on coal production, coal reserves, balance of payments, employment and economic vitality of communities in the nation's coal mining regions."⁹² The Committee maintained that in the case of Appalachian coal, six rules alone could add as much as \$17.17 per ton to the cost of producing coal in some mines. In the midwest, it could cost 6.11 more a ton.⁹³ The Joint Committee's criticism of OSM's economic analysis has received some support from the Carter Administration's Regulatory Analysis Review Group. The group reported that the proposed federal surface mining controls are so prohibitive that they might "lock out" billions of tons of western coal and cost anywhere from \$2 billion to \$3 billion a year.⁹⁴

After the close of the comment period on November 27, 1978, OSM initially refused to receive any further comments. However, under pressure from the Council of Economic Advisors (CEA), the administrative record was re-opened for further comment on documents filed by CEA.⁹⁵ The additional economic input from the administration's advisors is the subject of new suit in U.S. District Court filed by Natural Resources Defense Council, the National Wildlife Federation and the Council of Southern Mountains.⁹⁵ The action alleges that the information supplied to OSM by CEA on the cost impact of the regulations had "tainted" the comment process,⁹⁶ and the groups seek to enjoin OSM from considering these comments and prohibit further meetings with CEA.⁹⁶ The outcome of this litigation is, as yet, unknown.

In response to the requests of the coal industry, the House Subcommittee on energy and the Environment held two days of hearings on OSM's implementation of SMCRA in March. "Almost 45 witnesses raised a continuous drumbeat of criticism against OSM."⁹⁷ One of the focal points of this criticism was the OSM deadline for submission of state programs. Governor Julian Carroll (Kentucky) and Governor Ed Herschler (Wyoming) criticized the rigidity of OSM deadlines and expressed concern that OSM had not afforded the states the primary role contemplated by SMCRA. On the other hand, environmental organizations accused the states of "foot dragging" in refusing to upgrade existing state programs.

The Final Permanent Regulations were finally issued on March 13, 1979,⁹⁸ nearly a month after OSM's original estimate⁹⁹ and over seven months from the SMCRA deadline.¹⁰⁰ The issuance of these regulations heightened the coal industry's clamor about state programs being unable to meet the August 3, 1979 deadline. In response to this concern, Secretary Andrus decided to seek Congressional amendment of SMCRA to allow the states additional time to submit their proposals.¹⁰¹ Secretary Andrus announced his decision at oversight hearings held by the Senate Subcommittee on Energy Resources and Materials Production on June 19 and 21, 1979. If these new deadlines are approved by Congress, the states would have until March 3, 1980 to finalize their applications.

The promulgation of the final rules for the permanent regulatory program also prompted the American Mining Congress, the National Coal Association and 105 of their member coal companies to file suit challenging the legality of the final regulations.¹⁰² The regulations were also challenged in the same court by seven environmental groups including the National Wildlife Federation and the Natural Resources Defense Council.¹⁰³ Both of these suits seek an injunction to prevent the Secretary from enforcing or applying the contested regulations.¹⁰⁴ The outcome of these challenges will have important impacts on the coal industry and the survival of the permanent regulatory program.

Summary: The response of the coal industry to SMCRA varies from voluntary compliance to frustration and anger. But discontent is but one of the prices government, the industry and the consumer must pay for a comprehensive

federal surface mining program. It is certainly not easy to design and implement a plan applicable to all 50 states, and the end of the difficulties with compliance is not yet in sight. However, sincere efforts on both sides will make dealing with the realities (both good and bad) of the SMCRA less difficult.

Legal Footnotes and References

- ¹Public Law 95-87, 91 Stat. 445
30 U.S.C.A. § 1201 et seq. (1979)
- ²1977 U.S. Code Congressional and Administrative News, p. 632.
- ³30 U.S.C.A. §1251 et seq. (1979), Subchapter V - Control of Environmental Impacts of Surface Coal Mining
- ⁴These standards are listed in 30 U.S.C.A. §1265 (b) and (d) (1979). The standards implemented during the interim regulatory program include §1265 (b) (2), (3), (5), (10), (13), (15), (19) and §1265 (d) (1).
- ⁵30 U.S.C.A. §1253 (1979).
- ⁶44 Fed. Reg. 15312 (March 13, 1978)
- ⁷The entire text of the performance standards is found in 30 U.S.C.A. §1265 et seq. (1979).
- ⁸Coal Age, vol. 83, no. 9 (September, 1978) p. 11.
- ⁹Mining Congress Journal, vol. 64, no. 2 (February, 1978) p. 112.
- ¹⁰See the consistency provisions in 30 U.S.C.A. §1255 (a) (1979) and regulations defining consistency in 44 Fed. Reg. 15324 (March 13, 1978) (To be codified in 30 C.F.R. § 730.5 (a)).
- ¹¹Daniel Kelly, an attorney with the firm of Ice, Miller, Donadio and Ryan, Indianapolis, IN and counsel for the AMAX Coal Company; personal communication.
- ¹²West Virginia and Pennsylvania are in Region I, Illinois, Indiana and Ohio are in Region III, and Kentucky is in Region II.
- ¹³"...sufficient flexibility is inherent in the Act to allow both operators and Government to diligently pursue implementation." Implementation of the Surface Mining Reclamation and Control Act of 1977: Oversight Hearings Before the House Subcommittee on Energy and the Environment, 95th Cong. 2nd Sess. 6 (1978) (statement of Walter Heine, OSM Director). Hereafter cited as "Oversight Hearings Report."
- ¹⁴"Someway, somehow we must have a cooperative relationship between industry and regulators if we are to succeed in attaining the objectives of the law and meet our national energy goals...instead of a cold war we need a detente ...instead of an adverse relationship we need a flexibly cooperative attitude." E.R. Phelps, President, Peabody Coal Co. and Chairman of the Joint National Coal Association/American Mining Congress Committee on Surface Mine Regulations. Mining Congress Journal, vol. 64, no. 2 (February, 1978) p. 113.

- ¹⁵30 U.S.C.A. § 1265 (b) (3) (1979) and 44 Fed. Reg. 15411 (March 13, 1978) (To be codified in 30 C.F.R. §§816.102-105).

In actual mining operations "approximate original contour" usually results in a slightly rolling topography. Most ORBES states have been dealing with type of requirement for sometime (see Table 16). This federal requirement will tend to perpetuate the trend toward pastoral and agricultural reclamation of surface mined lands.

- ¹⁶See Final Environmental Statement, Permanent Regulatory Program Implementing Section 501 (b) of the Surface Mining Control and Reclamation Act of 1977, U.S. Dept. Int. p. BIII-11 to -16.

- ¹⁷See "Coal Surface Mining Reclamation Costs," U.S. Dept. Int., Bureau of Mines Circular 8695 (1976) and Alan M. Schlottman, Environmental Regulation and the Allocation of Coal, Praeger Publishers (New York: 1977) p.70-104.

- ¹⁸Rick Sarver, Director of Reclamation, Mac Energy Division, Valley Coal, Coonville, Ohio, personal communication.

- ¹⁹Irwin Reiss, President, Meadowlark Farms, Inc. (a subsidiary of AMAX Coal Company, Indianapolis, IN), personal communication.

- ²⁰See "Reclaiming Land for Profit," Coal Age, (October, 1963) p. 94. Meadowlark Farms, Inc. is now a division of AMAX Coal Company.

- ²¹Coal Mining and Processing, vol. 15, no. 3 (March, 1978) p. 64A.

- ²²See Steep Slope Mining and Mountain Top Removal Section, supra.

- ²³Tom Testa, Park Ranger, Goose Lake Prairie State Park; Coal City Area Club member; personal communication.

- ²⁴30 U.S.C.A. § 1265 (1979).

- ²⁵30 U.S.C.A. § 1265 (b)(19) (1979).

- ²⁶30 U.S.C.A. § 1265 (b)(20) (1979). (To be codified in 30 C.F.R. §816.111 (a)).

- ²⁷44 Fed. Reg. 15413 (March 13, 1979).

- ²⁸IBID. § 816.111 (b) (3).

- ²⁹IBID. § 816.116(a).

- ³⁰IBID. § 816.116(b)(1) and (b)(3).

- ³¹Rick Sarver, Director of Reclamation, Mac Energy, Coonville, Ohio; personal communication.

- ³²30 U.S.C.A. § 1257 (b) (16) (1979) indicates that a soil survey should be made of potentially minable farmland after an initial reconnaissance inspection indicates that land may be prime farmland.

- ³³The special standards are found in 30 U.S.C.A. § 1265 (b)(7) (1979).
- ³⁴44 Fed. Reg. 15451 (March 13, 1979). (To be codified in 30 C.F.R. § 823.1-.15).
- ³⁵IBID. § 823.14.
- ³⁶K.C. Bowling, "State Problems in Implementing the Federal Surface Mine Law," Mining Congress Journal, vol. 64, no. 10 (October, 1978) p. 72, and 43 Fed. Reg. 22459 (May 25, 1978).
- ³⁷Coal Mining & Processing, vol. 15, no. 9 (September, 1978) p. 36.
- ³⁸In re Surface Mine Litigation, 452 F. Supp. 327 (D.D.C. 1978).
- ³⁹"There are five principal areas on which we did receive quite a bit of public comment...Third,...prime farmlands..." Statement of Walter Heine, OSM Director, Oversight Hearings Report, p. 6.
- ⁴⁰30 U.S.C.A. § 1265 (c)(1) and (d) (1979).
- ⁴¹"Contour mining is getting much tougher now with very tall highwalls..." Bruce Burgess, West Virginia coal operator, "Mining Projects Add Building Space in Mountainous Areas," Coal Mining and Processing, vol. 15, no. 3 (March, 1978) p. 80.
- ⁴²"Steep Slope Mining and the Surface Mining Control and Reclamation Act of 1977," Mining Congress Journal, vol. 64, no. 9 (September, 1978) p. 233.
- ⁴³44 Fed. Reg. 15454 (March 13, 1978) (To be codified in 30 C.F.R. § 826.15(a) and (b)).
- ⁴⁴Charles F. Peters, Division of Reclamation, Department of Natural Resources and Environmental Protection, the Commonwealth of Kentucky, personal communication.
- ⁴⁵30 U.S.C.A. § 1265 (c)(2) (1979). 44 Fed. Reg. 15452 (March 13, 1979) (To be codified in 30 C.F.R. § 824.11 (a)(5)).
- ⁴⁶Testimony of James Pitsenbarger, Reclamation Director, West Virginia Department of Natural Resources, Oversight Hearings Report, p. 13.
- ⁴⁷"Mining Projects Add Building Space in Mountainous Areas," Coal Mining and Processing, vol. 15, no. 3 (March, 1978) p. 80.
- ⁴⁸"Pittston Sets Up Large Valley Fill," Coal Age, vol. 82, no. 12 (December, 1977) p. 116.
- ⁴⁹Proposed Federal Regulations for the Interim Program, 42 Fed. Reg. 62683 (December 13, 1977) § 715.15 (b).
- ⁵⁰See 30 C.F.R. § 715.15 (b)(1979).

- ⁵¹For example, Independence High School, Beckley, West Virginia, another high school near Welch, West Virginia plus a large commercial shopping center near Clarksburg, West Virginia were all built on mountaintop removal and valley fills. "Surface Mining Regulations Spell Disaster for Appalachia," Coal Mining and Processing, vol. 15, no 5 (June, 1978) p. 72.
- ⁵²Oversight Hearings Report, p. 38.
- ⁵³Oversight Hearings Report, p. 238.
- ⁵⁴Carl Bagge, President, National Coal Association, "Coal - The Once and Future KING," Coal Mining and Processing, vol. 15, no. 1 (January, 1978) p. 57.
- ⁵⁵30 U.S.C.A. 1252 (b) (1979).
- ⁵⁶30 U.S.C.A. 1252 (c) (1979).
- ⁵⁷Oversight Hearings Report, p. 6. The appropriations for OSM (\$30,880,000) were finalized by Public Law 95-240 (92 Stat 109) on March 7, 1978.
- ⁵⁸President Carter nominated Heine for Director on October 19, 1978 and Heine was confirmed by the Senate on December 6, 1978. "Update on Surface Mining Legislation," Mining Congress Journal, vol. 64, no. 2 (February, 1978) p. 116.
- ⁵⁹Carl Bagge, "Coal - The Once and Future KING," Coal Mining and Processing, vol. 15, no. 1 (January, 1978) p. 57.
- ⁶⁰42 Fed. Reg. 44920 (September 7, 1977).
- ⁶¹42 Fed. Reg. 62639 (December 13, 1977).
- ⁶²R.E. Samples, chief executive of Consolidation Coal Company in "Surface Mining Regulations Spell Disaster for Appalachia," Coal Mining and Processing, vol. 15, no. 5 (June, 1978) p. 70.
- ⁶³H.M. Sheldon, attorney for the State of Illinois, Coal Mining and Processing, vol. 14, no. 12 (December, 1977) p. 36.
- ⁶⁴Oversight Hearings Report, p. 60.
- ⁶⁵"Surface Mining Regulations Spell Disaster for Appalachia," Coal Mining and Processing, vol. 15, no. 5 (June, 1978) p. 71.
- ⁶⁶43 Fed. Reg. 8090 (February 27, 1978). See also David G. Todd, "Surface Mining Regulations and Litigation for 1978," Mining Congress Journal, vol. 65, no. 2 (February, 1979) p. 48.
- ⁶⁷IBID.
- ⁶⁸Oversight Hearings Report, p. 10.
- ⁶⁹Oversight Hearings Report, p. 3 and 4.

- ⁷⁰"Surface Mining Regulations Spell Disaster for Appalachia," Coal Mining and Processing, vol. 15, no. 5 (June, 1978) p. 70.
- ⁷¹43 Fed. Reg. 8090 (February 27, 1978).
- ⁷²"Surface Mining Regulations Spell Disaster for Appalachia," Coal Mining and Processing, vol. 15, no. 5 (June, 1978) p. 70.
- ⁷³43 Fed. Reg. 8091 (February 27, 1978) §710.11 (d)(3).
- ⁷⁴"Why Industry Can't Cope with 1977 Surface Mining Act," Coal Mining and Processing, vol. 15, no. 6 (June, 1978) p. 69. See also Nicholas P. Chironis, "A Small Operator Survives in Ohio," Coal Age, vol. 84, no. 3 (March, 1979) p. 74.
- ⁷⁵452 F. Supp. 327 (D.D.C. 1978) A summary of In re Surface Mining Regulation Litigation is available in 8 Environmental Law Reporter 20407 (1978).
- ⁷⁶In re Surface Mining Regulation Litigation, 452 F. Supp. 327, 323 (D.D.C. 1978).
- ⁷⁷See 46 U.S. Law Week 2665 (1978) and David G. Todd, "Surface Mining Regulations and Litigation for 1978," Mining Congress Journal, vol. 65, no. 2 (February, 1979) p. 49.
- ⁷⁸David G. Todd, "Surface Mining Regulations and Litigation for 1978," Mining Congress Journal, vol. 65, no. 2 (February, 1979) p. 49.
- ⁷⁹In re Surface Mining Regulation Litigation, 456 F. Supp. 1301 (D.D.C. 1978).
- ⁸⁰See David G. Todd, "Surface Mining Regulations and Litigation for 1978," Mining Congress Journal, vol. 65, no. 2 (February, 1979) p. 50, Charles Cook, Edward Green and David Todd, "Spotlight on Surface Mining," Mining Congress Journal, vol. 65, no. 4 (April, 1979) p. 17, and Charles Cook, Edward Green and David Todd, "Spotlight on Surface Mining," Mining Congress Journal, vol. 65, no. 7 (July 1979) p. 18.
- ⁸¹Indiana v. Andrus, Civ. No. 1P 78-500-C (S.D. In., Filed August 16, 1978) and Indiana Coal Association v U.S. Civ. No. 1P 78-501-C (S.D. In., filed August 16, 1978). These cases have been consolidated. See also David G. Todd, "Surface Mining Regulations and Litigation for 1978," Mining Congress Journal, vol. 65, no. 2 (February, 1979) p. 50.
- ⁸²David G. Todd, "Surface Mining Regulations and Litigation for 1978," Mining Congress Journal, vol. 65, no. 2 (February, 1979) p. 50.
- ⁸³Charles Cook, Edward Green and David Todd, "Spotlight on Surface Mining," Mining Congress Journal, vol. 65, no. 4 (April, 1979) p. 17 and "Industry News," Coal Mining and Processing, v. 16, no. 4 (April 1979) p. 41.
- ⁸⁴43 Fed. Reg. 41662 (September 18, 1978).

- ⁸⁵This joint committee has been instrumental in evaluating and commenting on the OSM regulations as the regulations have been issued. See David G. Todd, "Surface Mining Regulations and Litigation for 1978," Mining Congress Journal, vol. 65, no. 2 (February, 1979) p. 45.
- ⁸⁶Testimony of Harrison Loesch, vice president (government relations), Peabody Coal Co., in "Industry News," Coal Mining and Processing, vol. 16, no. 1 (January 1979) p. 31.
- ⁸⁷IBID., Testimony of John Paul, vice president (public affairs), Amax Coal Co.
- ⁸⁸IBID., Testimony of Robin Turner, vice president (administration), North American Coal Co. He stated that the proposed regulations for the permanent state programs "are exceedingly complex in their demands on the states. They impose a series of unnecessary procedural hurdles which can unfairly trip up states which are making good faith efforts to have their plans approved."
- ⁸⁹IBID., p. 32, Testimony of Steve Young, vice president (government affairs), Consolidation Coal Co.
- ⁹⁰David G. Todd, "Surface Mining Regulations and Litigation for 1978," American Mining Congress Journal, vol. 65, no. 2 (February 1979) p. 46.
- ⁹¹IBID. p. 47.
- ⁹²IBID.
- ⁹³Henry Divorshak, "Wheels of Government," Mining Congress Journal, vol. 65, no. 1 (January, 1979) p. 6 and "Industry News," Coal Mining and Processing, vol. 16, no. 2 (February, 1979) p. 29.
- ⁹⁴IBID.
- ⁹⁵"Industry News," Coal Mining and Processing, vol. 16, no. 3 (March, 1979) p. 8.
- ⁹⁶IBID.
- ⁹⁷Charles Cook, Edward Green and David Todd, "Spotlight on Surface Mining," Mining Congress Journal, vol. 65, no. 4 (April, 1979) p. 16.
- ⁹⁸44 Fed. Reg. 15312 (March 13, 1979).
- ⁹⁹"Industry News," Coal Mining and Processing, vol. 16, no. 4 (April, 1979) p. 42.
- ¹⁰⁰30 U.S.C.A. § 1251 (b) (1979).
- ¹⁰¹Charles Cook, Edward Green and David Todd, "Spotlight on Surface Mining," Mining Congress Journal, vol. 65, no. 7 (July, 1979) p. 16.

¹⁰²Charles Cook, Edward Green and David Todd, "Spotlight on Surface Mining,"
Mining Congress Journal, vol. 65, no. 6 (June, 1979) p. 15.

¹⁰³IBID.

¹⁰⁴IBID.

5. QUANTITATIVE DATA ON COAL RESERVES AND MINING ACTIVITY

This chapter provides baseline data for relating various reserves and mining with the ecological capabilities of the surface. Obviously, much depends on the political and economic climate, but this chapter shows several broad relationships which affect recoverability. Of particular interest is the relation between surface land use and amount of surface disturbed per ton of coal mined.

Minable Coal Reserves

Thomson and York (1975) provide tonnage and sulfur content of economically recoverable reserves in the ORBES region. Recent trends in mining set economic criteria. Tonnage and sulfur contents have been derived from an extensive review of state publications on reserves as well as through direct consultation with the Illinois and Indiana Geological Surveys pertaining to unpublished data.

Strippable reserves within ORBES counties are provided in Figure 5-1. Deep minable reserves are shown in Figure 5-2. Deep-minable reserves exceed strippable reserves in every state, but not in every county. In Kentucky-West, efficient mining methods (60% extraction if deep-mined, 90% if surface-mined) would bring potential surface production to within two-thirds of potential deep production. In other states, potential deep production is many times larger than potential surface production, suggesting that the ultimate method will be production from deep mines.

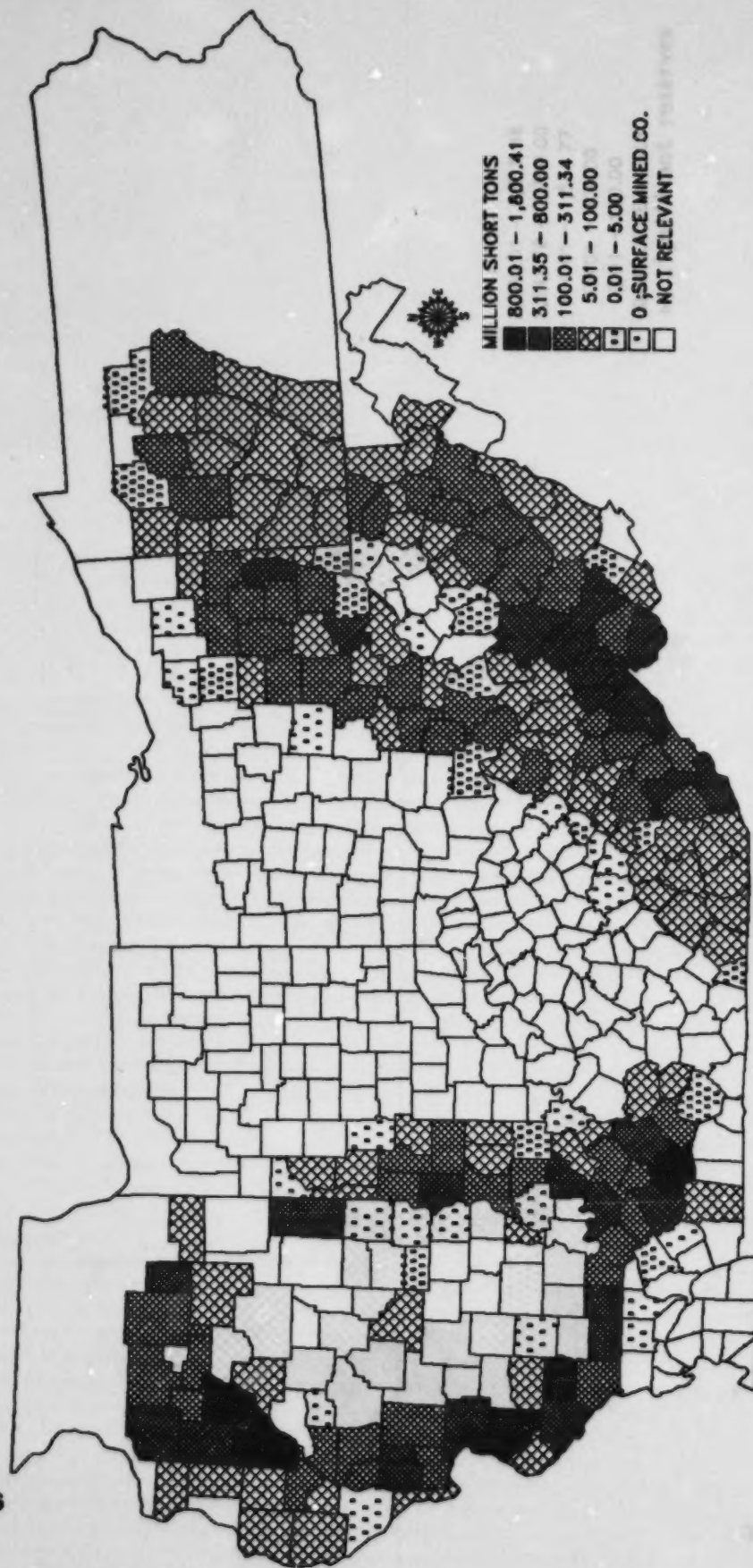
Low sulfur coal ($\leq 1\%$), useful toward meeting clean air standards, is most abundant in southeastern West Virginia and along the southeastern border of eastern Kentucky. Important counties are ranked according to tonnage and method of mining in Table 5-1. The Eastern Interior Basin (hence Illinois and Indiana) contains very little low sulfur coal.

History of Surface Mine Production

As this report will demonstrate, there are general and regional relationships between production and area of land surface disturbed. Since some ecological communities and related land uses require decades to develop, a knowledge of historical production is relevant.

Figure 5-1 SURFACE MINEABLE RESERVES IN 1974

36

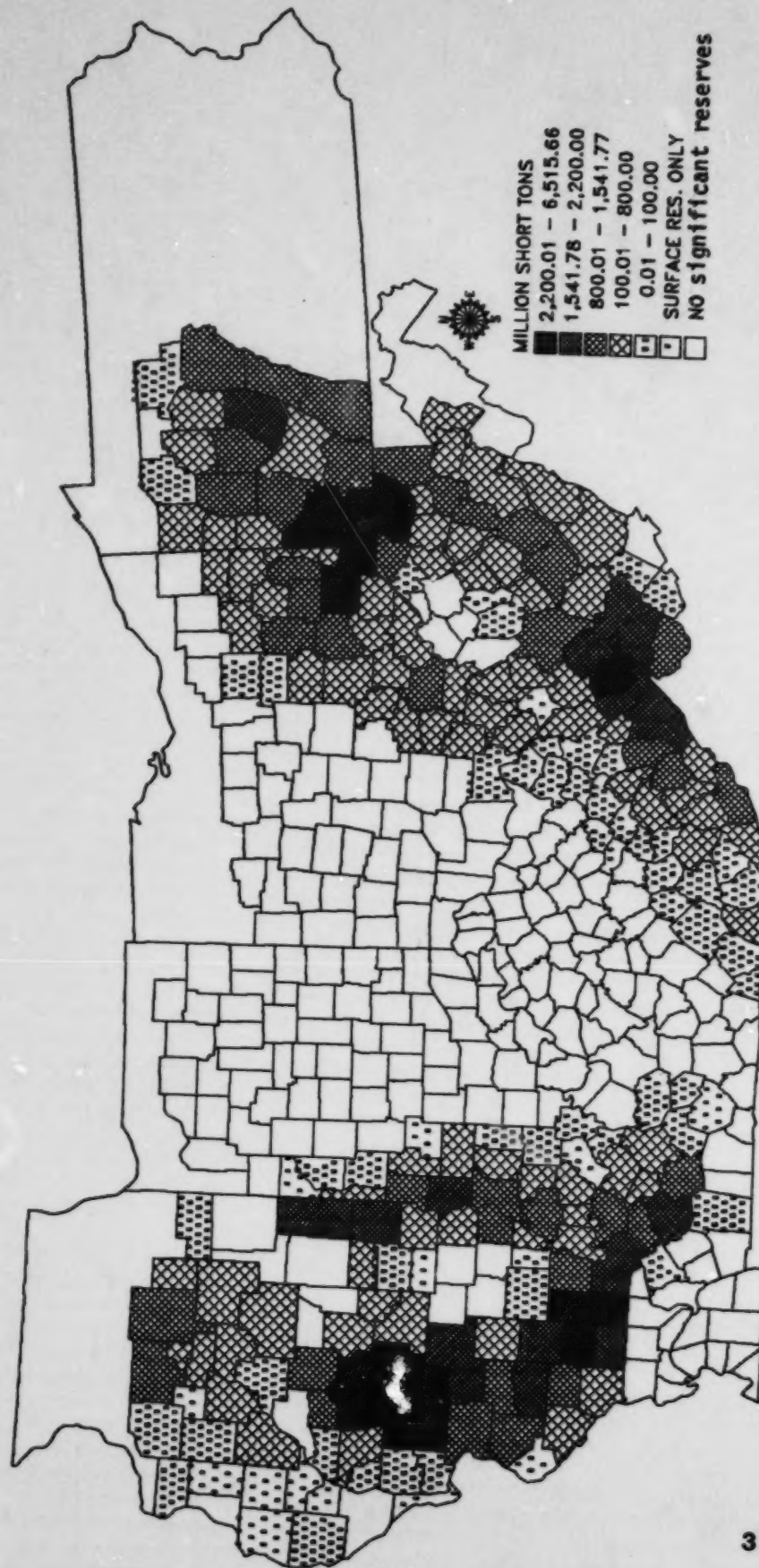


Sources: Thomson and York, 1975 (surface-mined counties identified through sources listed with Figures 5-3 and 5-5)

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Figure 5-2

DEEP MINEABLE RESERVES IN 1974



To facilitate location of mined and mining areas geographically, we have compiled data on total production at the county level (Figure 5-3). These data suffer from several types of problems: 1) failure to report tonnage, 2) concealment of tonnage within multiple county or state totals, and 3) tonnage reported from counties where it was not mined. The last type of problem occurs because some reports use the tipple as the location of the mine, although the tipple may be located in a county adjacent to the land being mined.

Recent Surface Production

Figure 5-4 gives a view of the ongoing trend in surface-mining activity. This information in combination with data on reserves is useful in estimating regional locations of future mining activity. Here, we have averaged 1976 production, our most recent information at the time of this task (Walls et al. 1979, gave 1977 surface production for all states but Indiana), with 1974 and 1975 production. The 3-year average tends to even out year to year variation and gives better representation of small producing counties than would any single year taken alone.

Geographical Relationships Between Strippable Reserves and Surface Mining Activity

In a broad sense, counties with high reserves (>200,000 million tons) have already experienced high levels of extraction (>30 million tons) through the ORBES region (no comparisons, West Virginia). This is clearly the case in 24 of 42 counties (57%) and at least modestly so in 29 of 42 counties (69%). In 11 counties, all located in the Eastern Interior Basin, exploitation of large reserves is slight. These counties are: in Illinois - Gallatin, Greene, Grundy, Henry, Knox, Madison, Morgan, Schuyler, and Stark; and in Kentucky-West - Butler and Henderson. Very lightly exploited counties include Greene, Madison, and Morgan in Illinois and Henderson (no record of surface mining) in Kentucky. Thus, depending on the quality of the coal, on local ordinances, and on the economics of reclamation, these counties can be expected to become focal points of surface mining in the future.

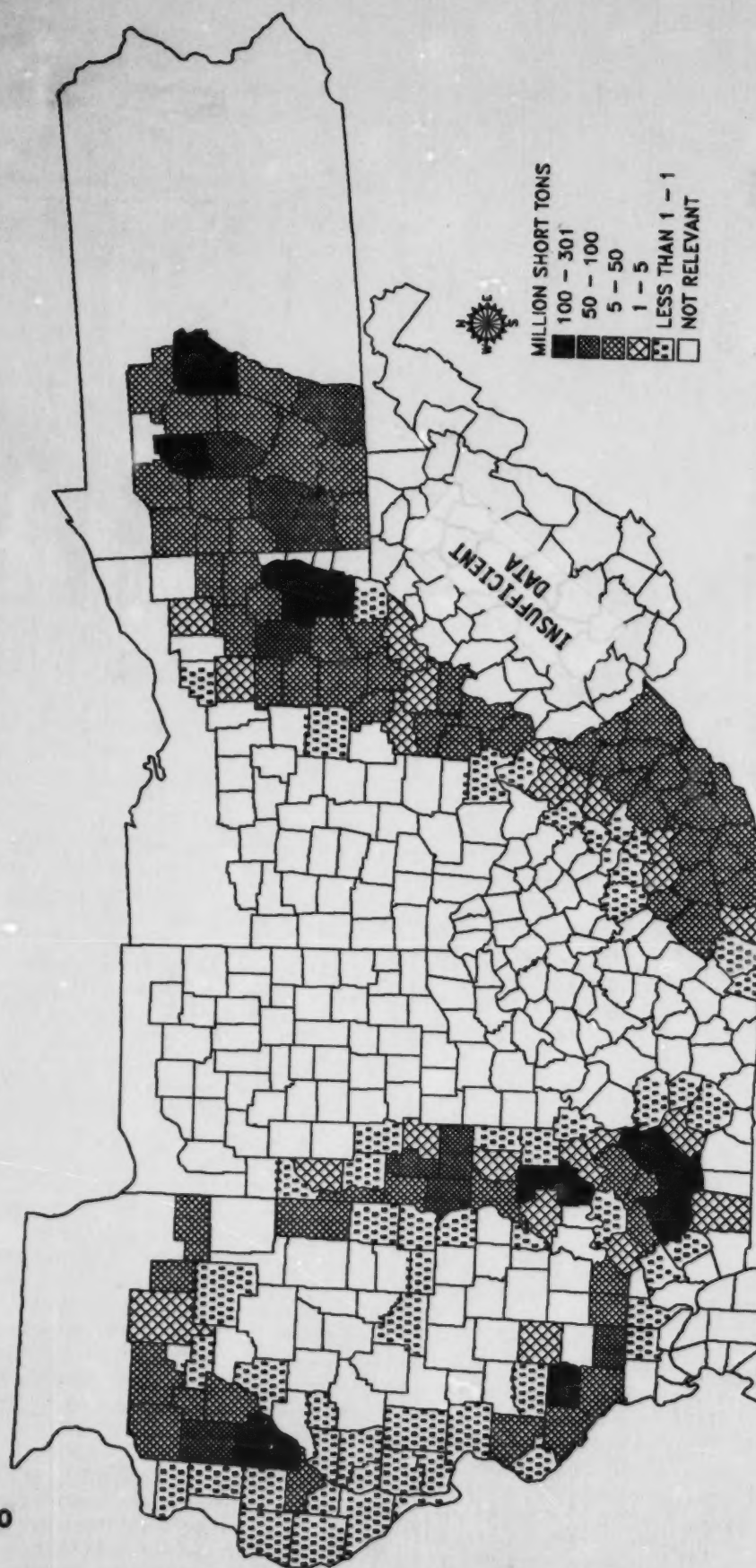
In contrast, extensive extraction (>30 million tons) has occurred in nine counties with moderately low reserves (<100 million tons) remaining. These counties are: in Pennsylvania - Allegheny, Armstrong, Cambria, Indiana, Jefferson, Somerset, Washington, and Westmoreland; in Kentucky-East - Bell County. Counties with extensively depleted reserves include Allegheny, Elk, and Venango Counties in Pennsylvania.

Thus, within the ORBES region as a whole, Pennsylvania has a mature surface-mining industry with relatively high depletion of its reserves (although still only about 25-50% depleted), while Illinois has extensive reserves. None of the counties involved in this comparison ranks high in strippable reserves of low (<1%) sulfur coal.

Figure 5-3

HISTORICAL SUMMARY OF SURFACE MINE PRODUCTION BY COUNTY

40

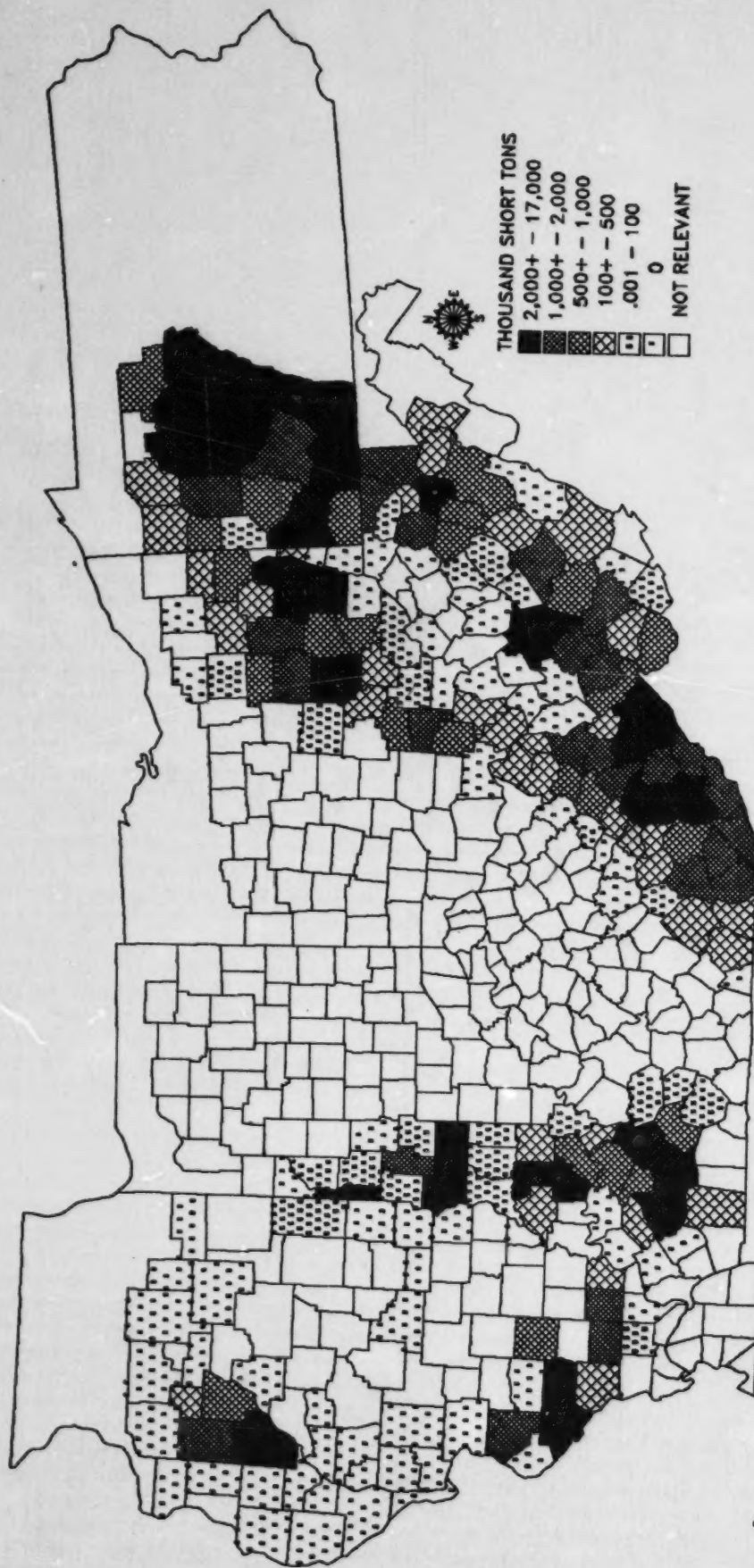


Sources: U.S. Department of Interior, Bureau of Mines, 1924-1977 (Minerals Year-books, 1923-1975)
 Also, for Illinois: Illinois Department of Mines and Minerals, 1955 through 1976 (Coal Reports)
 Indiana: Indiana Department of Natural Resources, Geological Survey, unpublished data; Indiana Coal Association, unpublished reports
 Kentucky: Currents and Smith, 1977
 Ohio: Ohio Department of Natural Resources, Division of Mines, 1956
 Pennsylvania: Pennsylvania Department of Environmental Resources, 1941-1971 (Bituminous Coal Division Reports)

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Figure 5-4

THREE-YEAR AVERAGE SURFACE PRODUCTION (1974-1976)



Sources: Walls et al., 1979; U. S. Department of Interior, Bureau of Mines, 1975 Minerals Yearbook; and state agency reports as listed with Figure 5-3

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Total Affected Acreage by County

We needed to know what has happened to lands surface-mined for coal, and expected to find temporal and regional differences. We examined records of affected acreages as a first cut at this objective.

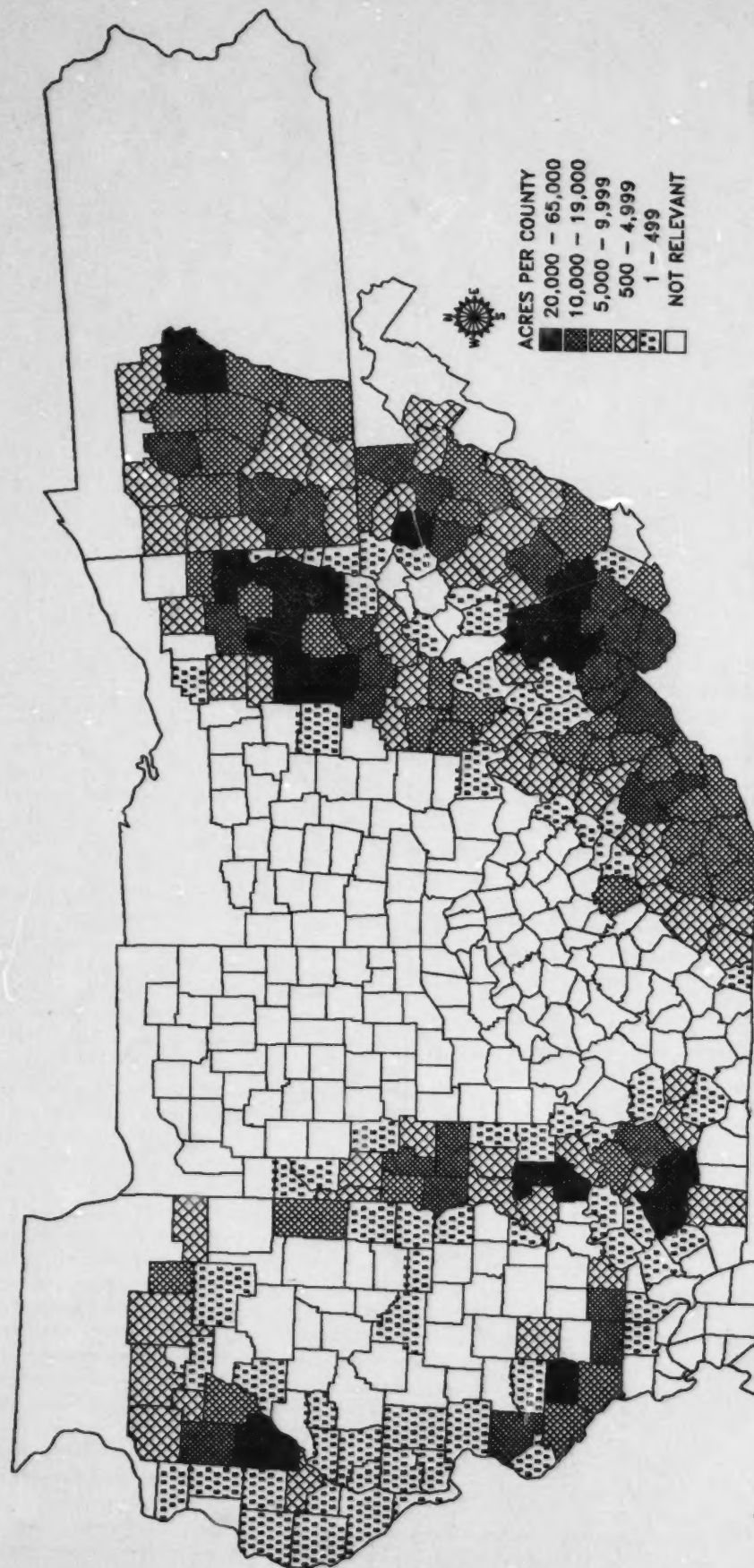
We obtained as much published county-level data as we could and supplemented this with unpublished data from the various state agencies responsible for permitting surface-mine operations. For every state there was a record of old (pre-1970) mined acreages. In all states except Ohio and Pennsylvania, mapping methods, often incorporating aerial photography, have been used to estimate old mined acreages. Thus, old and relatively recently mined areas were treated in the same manner and tabulated as to the date of survey. For Ohio and Pennsylvania we did not learn the method of determining acreage. Pennsylvania presented an additional complication; only inadequately reclaimed acreage was tabulated, while adequately reclaimed acreage went unassessed. The Pennsylvania survey failed to account for perhaps 50,000 acres affected prior to 1963 in the ORBES portion of Pennsylvania (see Davies et al., 1965, for the total affected acreage of Pennsylvania's bituminous coal basin).

To obtain data on acreages affected between 1970 and June, 1976, the termination date for our survey, we had to work with data derived from surface-mining permits. Table 3-2 lists the number of permits issued annually and explains the extent to which the various state divisions of reclamation had compiled the data before making it available to us. It is clear that the number of permits are issued for mining in the Eastern Interior Basin than in the Appalachian Basin. This difference corresponds to differences between the mining industries within the two basins; there are a few large mines in the Eastern Interior Basin and many small mines in the Appalachian Basin. The availability of the data varied from published reports for Illinois, through easily accessible files of original permits in Ohio, to massive and relatively inaccessible files of permits in Pennsylvania. A tally of the Pennsylvania permits proved to be beyond the capability of the present study. As an aside, it is worth noting that the floor space and staffing of the various divisions of reclamation tended to reflect the numbers of permits issued -- small and compact in Illinois and Indiana, large and extensively staffed in Kentucky and Pennsylvania.

Figure 5-5 shows county acreages of land affected by surface mining of coal from the earliest discernable excavations through June 30, 1976. In the preceding introduction we explained that both mapping and permit data were used to derive total acreages. Mapping methods are explained in the following references: Illinois (Haynes and Klimstra, 1975), Indiana (Powell, 1972), Kentucky-East (Eastern Kentucky University Cartographic Laboratory, 1975), and West Virginia (Schmidt and Stoneman, 1972). For the first three states, aerial photography, U.S. Geological Survey topographic maps, and planimetry were used for computing acreages. For West Virginia, aerial photography, topographic maps, and a method of estimating contour strip width from slope data were employed. Permitted acreage was available in two basin forms: the area of proposed mining activity (Kentucky-West, Kentucky-East, West

Figure 5-5

LAND AREA AFFECTED BY SURFACE MINING FOR COAL



Sources: Illinois: Illinois Department of Mines and Minerals, 1977
 Indiana: Powell, 1972; Indiana Department of Natural Resources, unpublished data
 Kentucky: Carter et.al., 1974; Eastern Kentucky University Cartographic Laboratory, 1975; Kentucky Department of Natural Resources and Environmental Protection, computer printout of permit data
 Ohio: Ohio Department of Natural Resources, 1973; Ohio stripmine permits, 1973-1976
 Pennsylvania: Pennsylvania Department of Environmental Resources, unpublished data
 West Virginia: Schmidt and Stoneman, 1972; West Virginia Department of Natural Resources, unpublished data

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Virginia) and the actual disturbed area as confirmed by inspection (Illinois, Indiana, Ohio). After consultation (Roger Hall, West Virginia Department of Natural Resources, Division of Reclamation, and Bill Rainey, West Virginia Surface Mining and Reclamation Association, personal communications) we concluded that 37% of the permitted acreage in mountainous areas may never be affected during mining. This acreage may serve only as a buffer zone to contain occasional accidental slippages of spoils. Thus, raw permit totals for Kentucky-East and West Virginia were multiplied by 0.63 before being incorporated into Table 5-4.

Since compilation of this material the Soil Conservation Service (U.S. Department of Agriculture, 1979) has obtained data on affected acreages. Their survey was completely independent from ours and based on consultation with local SCS officials. We have referred to this work in assessing accuracy of our data in Chapter 7.

Coal Refuse Areas

Coal refuse areas result from surface disposal of impurities separated from coal, either during the process of working deep-mine tunnels or during the cleaning of coal for shipping, or both. The refuse areas are variously known as mine dumps, gob areas (solid, rocky refuse in piles) or slurry areas (washings of fine particles in broad flat areas which are typically diked). These areas may be extremely toxic and unresponsive to the typical methods of reclaiming overburden. A careful survey of these areas is limited to Illinois (Klimstra and Terpening, 1974; Nawrot, Haynes, et al., 1977; Nawrot, Pursell, et al., 1977). In 1971 there were 5,500 acres of uncovered gob and slurry associated with surface mining, and in 1976 there were 4,637 acres similarly associated with underground mines. If we add the acreages of the other ORBES states to that of Illinois, the total area affected by gob, slurry, and toxic mine dumps probably exceeds 60,000 acres, given the increased contribution due to deep mining in the Appalachian Basin.

Land Area Requirements for Surface Mine Production

To project the impact of surface mining on land area we needed a relationship between coal tonnage and surface area. Three factors confound this relationship. 1) More land is disturbed than is actually mined. 2) The yield of land actually mined varies proportionally with the net thickness of the surface mineable coal seams underlying in the surface. Some ratios of mined land are given in Table 5-2. In the Appalachian Coal Field a greater proportion of unmined land is disturbed per ton of coal mined, than in the Eastern Interior Basin. 3) Edge to area ratios, according to Powell (1972), vary inversely with tonnage productivity. The hilliness of the Appalachian Coal Field necessitates contour stripping in a majority of mining operations, and contour stripping has a high edge to area ratio. Disturbance of unmined land

occurs through spreading of overburden on unmined land. To illustrate conventional contour-mining plans yielding maximum and minimum disturbances of unmined land Drnevich et al. (1976) have applied several plans to a given Landscape. With appropriate planning they reduced the disturbance of unmined land from 67% to 37% of the total disturbed area without reducing the mineable tonnage. However, the minimum disturbance on a 24% slope is about 1.5 times larger than the mined area compared to about 1.2 for typical area stripping in Illinois and Indiana (Table 5-2). An additional source of disturbance to unmined land in Appalachia results from the remoteness of many of the mine sites, which require long haul roads over unmined land for access.

Table 5-3 gives a 30-year record of the average seam thickness of mined seams according to state and region. With exception of West Virginia, thinner seams are mined in Appalachia than in the Eastern Interior Basin. This factor only exaggerates the high acreage to tonnage relationship to be expected in Appalachia, since on the average rather little surface-mineable coal underlies any given area of land surface.

Table 5-2
Ratio of Mined Land to Total Land Affected During Mining¹

State	% Mined
EASTERN INTERIOR COAL FIELD	
Illinois	83
Indiana	83
Kentucky-West	81
APPALACHIAN COAL FIELD	
Kentucky-East	61
Ohio	67
Pennsylvania	67
West Virginia	63

¹Source: Calculated from U.S. Department of Interior, Office of Surface Mining Reclamation and Enforcement, 1979: p. BIII-4.

Table 5-3 Average Thickness of Surface-Mined Coal Seams¹

State	Year					
	1946	1950	1955	1960	1965	1976
EASTERN INTERIOR BASIN						
	- feet -					
Illinois	4.5	5.0	4.8	5.0	5.3	4.3
Indiana	4.2	4.4	4.4	4.6	4.2	3.9
Kentucky-West	5.9	5.2	5.0	5.1	5.0	4.2
APPALACHIAN BASIN						
Kentucky-East	3.6	5.6	3.3	3.1	4.3	3.6
Ohio	3.7	3.8	3.8	3.7	3.6	3.1
Pennsylvania	4.1	3.7	3.2	3.2	3.2	3.2
West Virginia	6.1	5.5	5.8	4.9	4.9	4.3

¹Source: U.S. Department of the Interior, Minerals Yearbooks, except the Column 1976, which has been calculated from Keystone coal data.

Table 5-4

LAND AREA REQUIREMENTS
FOR SURFACE PRODUCTION

HISTORICAL GRAND TOTALS THROUGH 1970:

STATE	DATES OF PRODUCTION	PRODUCTION ¹ (1,000 TONS)	ACRES ²	ACRES PER MILLION TONS
EASTERN INTERIOR				
Illinois	1911 - 1970	729,162	157,320	216
Indiana	1914 - 1970	487,490	103,705	213
Kentucky-West ³	1927 - 1970	446,775	76,368	171
APPALACHIAN				
Kentucky-East	1928 - 1970	152,911	83,644	547
Ohio	1914 - 1970	700,200	282,632	404
Pennsylvania	1917 - 1963	498,385	133,600 ^{4,5}	268
West Virginia	1916 - 1970	523,205	251,446	481

EARLY 1970's:

STATE	SURFACE MINE PRODUCTION 1971 through 1975 INCLUSIVE (1,000 TONS)	ESTIMATED AFFECTED ACREAGE JULY 1971 through JUNE 1976	ACRES PER MILLION TONS
EASTERN INTERIOR			
Illinois	146,384	28,231 ⁶	193
Indiana	117,121	22,663 ⁶	194
Kentucky - West	157,282	27,215 ⁷	173
APPALACHIAN			
Kentucky - East	190,013	87,014 ⁷	458
Ohio	165,184	70,703 ⁶	428
Pennsylvania	153,853	No Data	
West Virginia	107,597	39,849 ⁷	370

¹Data from U.S. Department of Interior, Bureau of Mines, Minerals Yearbooks.²Sources as for Figure 5-1.³Caldwell, Crittenden, Hancock, Union, and Webster Counties omitted due to insufficient data.⁴This estimate refers to acres of abandoned strip mine lands, and is undoubtedly much less than the total affected area for the period (see text).⁵Source: Pennsylvania Department of Environmental Resources, unpublished map.⁶Affected acreages.⁷Permitted acreage reduced by .63.

Tables 5-4 and 5-5 give acreage to tonnage estimates for the ORBES region. The average estimates, which have been less accurately recorded over the years than tonnage, come from three different sources. Table 5-5 presents results compiled by local SCS officials from many sources of data. We can assume but not prove that a portion of each state estimate includes personal familiarity with conditions at the county level. The remainder may have been drawn from published reports. In Table 5-4 a majority of the data on acreages affected through 1970 come from aerial surveys often combined with field checks. Acreages affected during 1971 through 1975 rely heavily on summation of surface-mining permit data, either by state reclamation agencies or through this study. To obtain affected acreages we adjusted totals of raw permit data according to the advice of state reclamation people. Figure 5-6 gives a display of county data for the ORBES major coal producing counties. Both disturbed area and production represent average annual estimates for six years (1970-1975). It is evident that Appalachian Coal Field counties are less productive per unit of disturbed area than are the Eastern Interior Coal Field counties.

The tables confirm predictions: a mine operator must disturb more land in Appalachia per ton of coal than in the Eastern Interior Coal Field. The decimal ratios of Eastern Interior to Appalachia for Tables 5-4 and 5-5 are .48, .47, and .48 respectively. If we use the information in Table 5-5 and years 1960, 1965 and 1976 in Table 5-3 to approximate the difference, the area and seam width data as listed give a decimal ratio of .64, which is less extreme. On the basis of Powell's (1972) contrast of small surface mines in hilly southern Indiana vs. large mines in flat northern Indiana, we propose that Table 5-2 over-estimates the ratios of mined land to total affected land in Kentucky-East, Pennsylvania and West Virginia.

Table 5-5

LAND AREA REQUIREMENTS
FOR SURFACE PRODUCTION

HISTORICAL GRAND TOTALS THROUGH 1977:

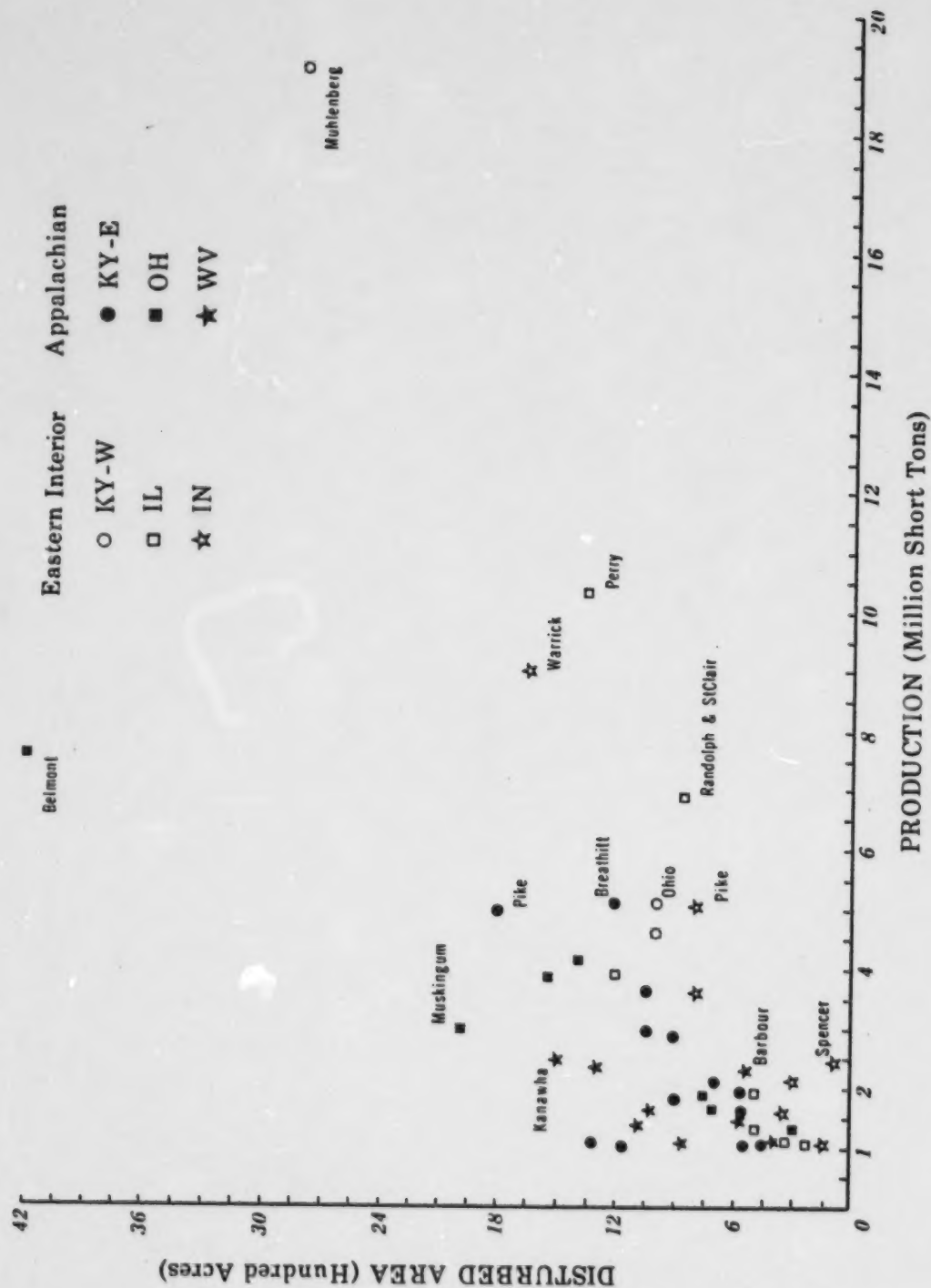
STATE ¹	DATES OF PRODUCTION	PRODUCTION ² (1,000 TONS)	ACRES ^{3,4}	ACRES PER MILLION TONS
EASTERN INTERIOR				
Illinois	1911-1977	927,062	240,707	260
Indiana	1914-1977	657,095	156,955	239
Kentucky-West	1927-1977	678,937	124,983	184
APPALACHIAN				
Kentucky-East	1928-1977	446,005	284,609	638
Ohio	1914-1977	928,414	438,329	472
Pennsylvania	1917-1977	889,552	386,370	434
West Virginia	1916-1977	672,445	228,027	339

¹ORBES Portions of States.²Data From U.S. Department of Interior, Bureau of Mines, Minerals Yearbooks.³Adapted From U.S. Department of Agriculture, Soil Conservation Service, 1979.⁴Acreage involved in sand, gravel and other non-coal mining may be included unavoidably. Such acreage should not exceed 10% of the totals.

Figure 5-6

Production vs. Disturbed Area

ORBES Counties of High and Intermediate Level Annual Production



6. SURFACE LAND USE IN THE REGIONS OF SURFACE-MINING ACTIVITY AND POTENTIAL

Introduction

The ORBES region supports many types of land use. Of these, agriculture and forest resources occupy the greatest acreages and conflict most severely with surface-mining activity.

Surface topography and potential and practiced land use influence requirements for reclamation. Briefly stated, land forms of the Eastern Interior Basin vary from flat or gently rolling topography with a local relief of 100-300 feet (typical of the greater part of this basin) to moderately steep hills with local relief of 300-500 feet (in southern Illinois and parts of western Kentucky). Land forms typical of the Appalachian Basin vary from steep hills and rolling topography with local relief of 300-1,000 feet (common in Ohio, northern West Virginia, and Pennsylvania) to steep mountains with a local relief of 1,000-3,000 feet (characteristic of eastern Kentucky and southern West Virginia) (the National Atlas, 1970).

Figure 6-1 provides a generalized map of dominant land uses. The Eastern Interior Basin and the Appalachian Basin contrast sharply. Row crop agriculture dominates in the former; forests are scarce. In the latter, row crop agriculture is scarce, and forests and forestry are important.

Agriculture

The importance of agriculture as an active as opposed to a potential land use in the Eastern Interior Basin and its relative unimportance in the Appalachian Basin are well illustrated in Stewart et al. (1975) and in the U.S. Agricultural Censuses conducted every five years.

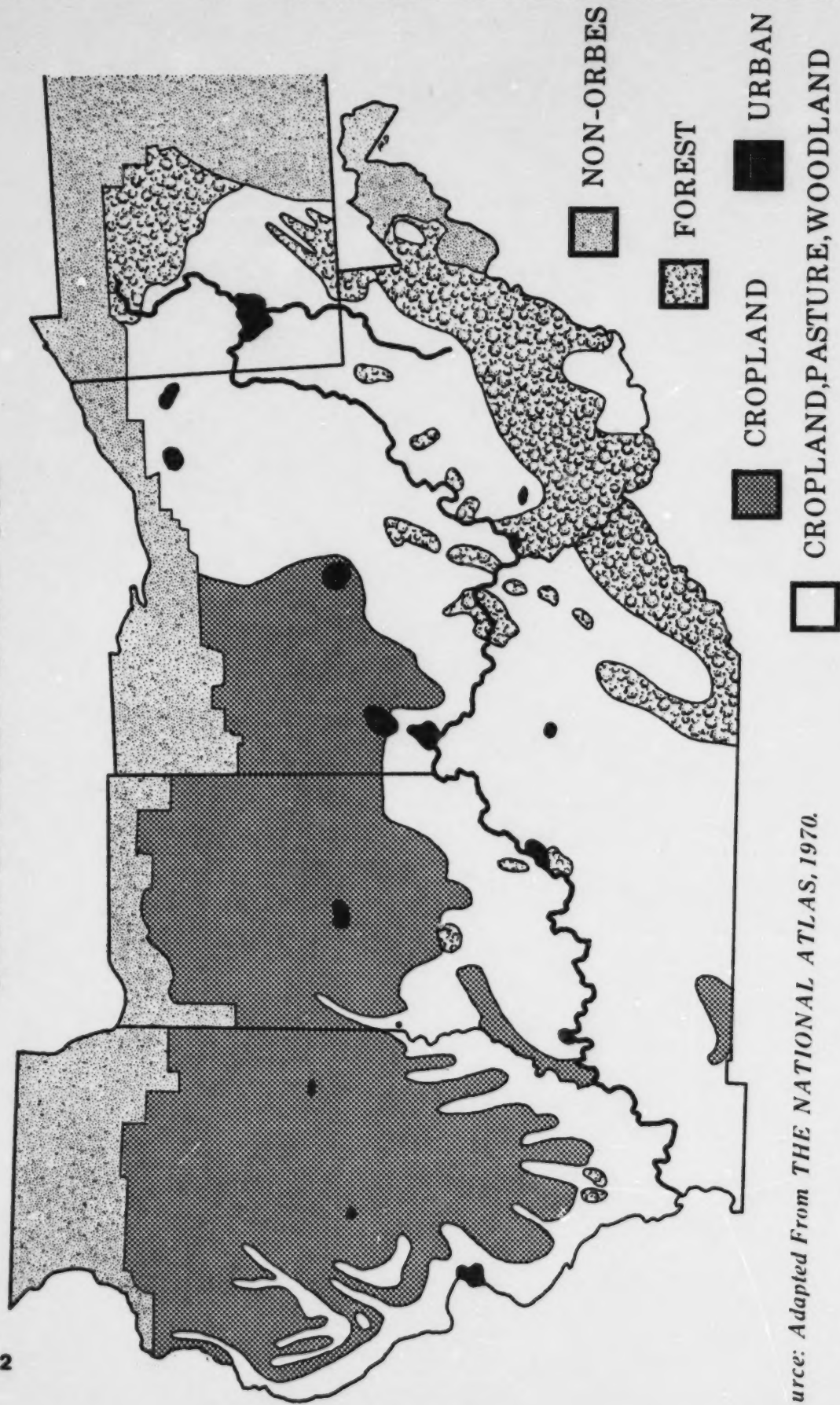
We conducted a survey by county (approximately) of agricultural activity in relation to present and potential, or reserve, surface-mining activity. Important features of this survey appear below, with counties containing large reserves of strippable coal underlined:

OHIO RIVER BASIN ENERGY STUDY PHASE II

Figure 6-1

GENERALIZED LAND USE

52



Corn: Important in Illinois in all surface-minable counties in an inverted "U" from Perry County, through Henry, Grundy, Vermilion, and Wabash Counties. Corn is an important crop in southwestern Indiana from Vigo through Sullivan, Daviess, Pike, and Warrick Counties. Corn production, lower than in Illinois and Indiana but still significant, occurs in Kentucky-West, in Stark, Carroll, and Columbiana Counties of Ohio, and in Mercer, Lawrence, Venango, and Butler Counties of Pennsylvania.

Soybeans: Production is most extensive in central Illinois where strip-pable reserves are relatively small and deep-minable reserves are extensive. However, the crop is clearly important in St. Clair, Madison, Scott, LaSalle, Grundy, and Gallatin Counties. Soybean production is also important in Daviess and Gibson Counties, Indiana.

Wheat: Production is important in a belt across southcentral Illinois and adjacent southern Indiana. The only county with extensive strip-pable reserves and wheat production is St. Clair County, Illinois.

Vegetables: Production is moderate in the vicinity of Vermilion County, Illinois, and lightly scattered in Stark and Columbiana Counties, Ohio, and across the ORBES region of Pennsylvania. Orchards are also represented sparsely in eastern Ohio and western Pennsylvania.

Cattle and Hogs: These animals, when raised for meat products, tend to be maintained close to sources of grain. Fattening of cattle is an important activity in much of Illinois, especially in the northern part including Henry, Bureau, and LaSalle Counties. Hog production occurs throughout Illinois, especially in the western part which includes such counties with major strippable reserves as Fulton, Greene, Henry, Knox, Madison, Peoria, and St. Clair. Hog production is also important in southwestern Indiana, including Knox and Sullivan Counties, and in Daviess, Henderson, and Union Counties, Kentucky.

Milk Cows: Grazing is scattered throughout the ORBES region with exception of southern West Virginia and most of Kentucky-East. Important grazing areas approximately include St. Clair and Washington Counties, Illinois; Coshocton, Holmes, and Wayne Counties, Ohio; and Butler and Lawrence Counties, Pennsylvania.

Chickens: This type of livestock, most often housed in buildings, does not have any special land requirements. Production is widely scattered throughout the ORBES region, but is lowest in West Virginia and southeastern Kentucky. An area of intense production occurs in Dubois County, Indiana.

To summarize, intensive agricultural production of many crops and livestock occurs in the Eastern Interior Basin, especially in Illinois. Agriculture is generally unimportant in the Appalachian Basin. With the possible exception of tobacco (not listed), the only agricultural resource in the coal basin of Kentucky-East and West Virginia appears to be chicken farming, and even this resource is trivial relative to production of chickens elsewhere in the ORBES region and in the eastern United States.

The potential for agricultural productivity in Illinois has been treated by Mausel et al. (1975). Emphasis was placed on topographic and soil characteristics. The region with the highest potential for productivity includes part or all of Champaign, DeWitt, Douglas, Logan, Macon, McClean, Moultrie, and Piatt Counties. None of these counties contain strippable reserves. Douglas, Logan, Macon, and McClean Counties have moderate to large deep-minable reserves. A moderately high potential for productivity occurs in all or part of several counties with strippable reserves: Bureau, Edgar, Grundy, LaSalle, Livingston, McDonough, Stark, Vermilion, and Warren.

Forestry

Considerable potential and practiced forestry occurs in the Appalachian Basin. The forest resources of Illinois, Indiana, Kentucky, and Ohio were evaluated in an ORBES Phase I Preliminary Technology Assessment Report (Volume II-A, Part 1: pp. 123-152). The forest resources of Pennsylvania and West Virginia have been reviewed by Kay et al. (1979) and Cardi (1979), respectively. Information on West Virginia and additional treatment of Kentucky are available in Oak Ridge National Laboratory (1978). These reviews have drawn extensively from U.S. Department of Agriculture, Forest Service Resource Bulletins for the six states.

A general conclusion is that forest covers a high percentage (often over 80%) of many of the counties in the Appalachian Basin. However, much of the forest has been harvested and remains commercially depleted and understocked with valuable species of trees for future harvests. In Ohio and Pennsylvania, forested acreages have increased substantially in the last 25 years, and in Pennsylvania the harvest capability has actually improved from an all-time low in the mid-1940's. Forests in central and southern West Virginia are extensive and contain a high volume of timber (Oak Ridge National Laboratory, 1978). The quality of forest in much of Kentucky-East, where over 80% of the land is forested has remained only fair.

Summary: Agriculture is an important land use in the Eastern Interior Basin, while forestry or the timber reserve is relatively unimportant. The converse is true of the Appalachian Basin. The greatest potential for conflicts between agricultural and surface mining occurs in Illinois. For forestry, the potential for conflict is greatest in central and southern West Virginia.

7. QUANTITATIVE LAND CLASSIFICATION

Introduction

Our approach to land classification reflects two major categories of land use, row crop agriculture and forest resources use. It also focuses on two constraints of the 1977 Federal SMCRA, Prime Farmlands and Steep Slopes. We recommend that our results be viewed as suggestive of focal points of future surface mining activity but at one or two levels of approximation removed from proven interaction. At the least removed level, the parameter which we explored is a direct measure of a land use or constraint variable. However, we do not demonstrate that coal reserves lie directly beneath specific areas of the land use or form; the best we do is assign rough levels of probability as explained in Chapter 9. Further removed from known interaction are parameters which only suggest land use and form. That is, the measure which we present is known to be correlated with a land use or form in the ORBES region, but does not indicate that land use or form in every case. Figures 7-1, 7-2 and 7-3 give inferential measures of land use. Figure 7-4 gives a direct measure of the steep slope constraint variable.

In each figure the form of data is percentage of county area occupied by the given parameter. In most cases the county areas are actually inventory acreages as defined by various state Soil Conservation Needs Inventories.

Land Capability Class 1 (Figure 7-1)

Land in this category is moderately level and has very few limitations for agricultural use. When such land has not been converted to urban, industrial or transportation uses, it is highly suited to row crop agriculture, and receives a state designation as Prime Farmland. A portion, perhaps half, of Class 2 land is also Prime Farmland.

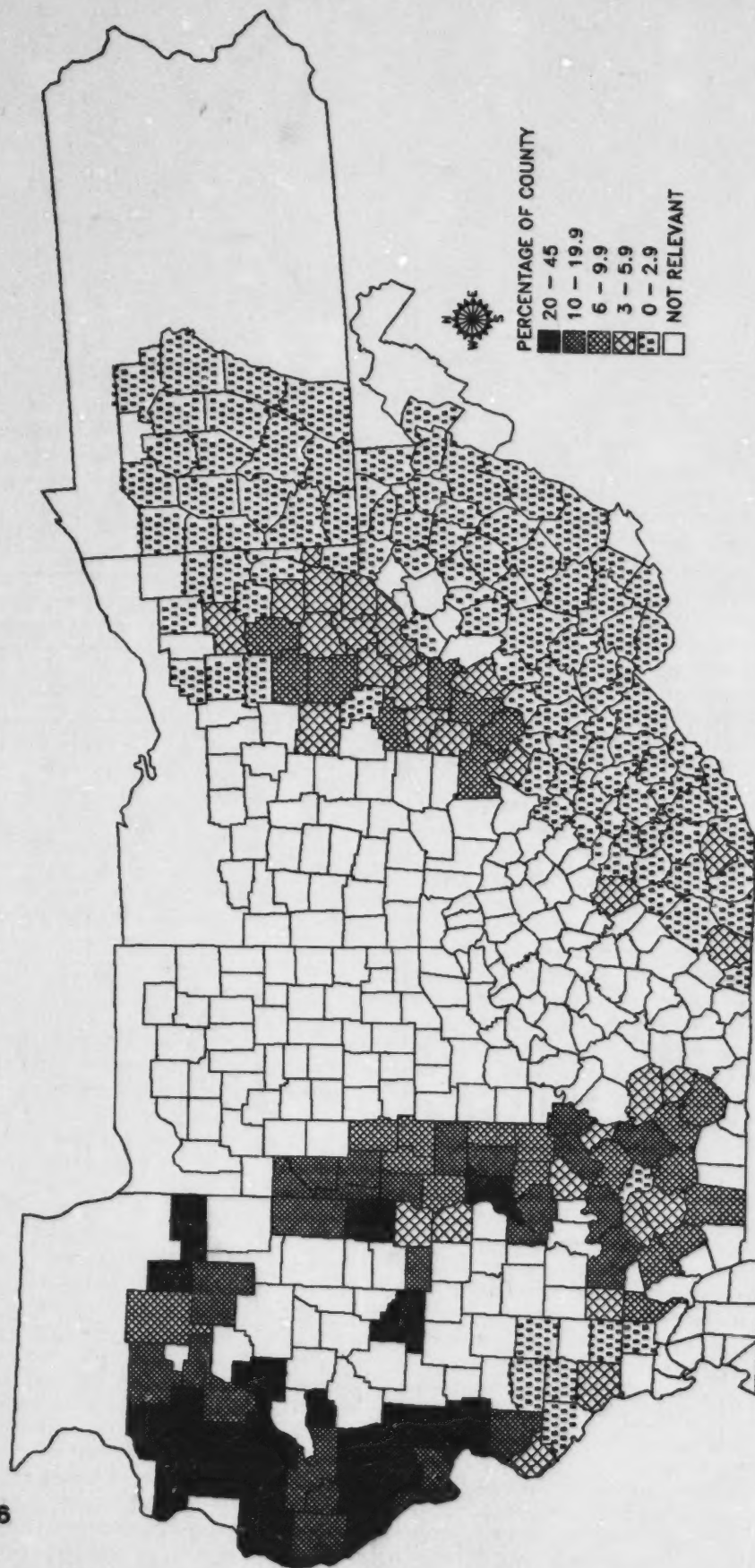
Land Capability Classes 7 and 8 (Figure 7-2)

Lands in these categories present serious hazards to agricultural utilization, and almost never support row crops. In the eastern portion of the ORBES region these lands tend to be steeply sloping. However, they can also

Figure 7-1

PRIME FARMLANDS: LAND CAPABILITY CLASS 1

56

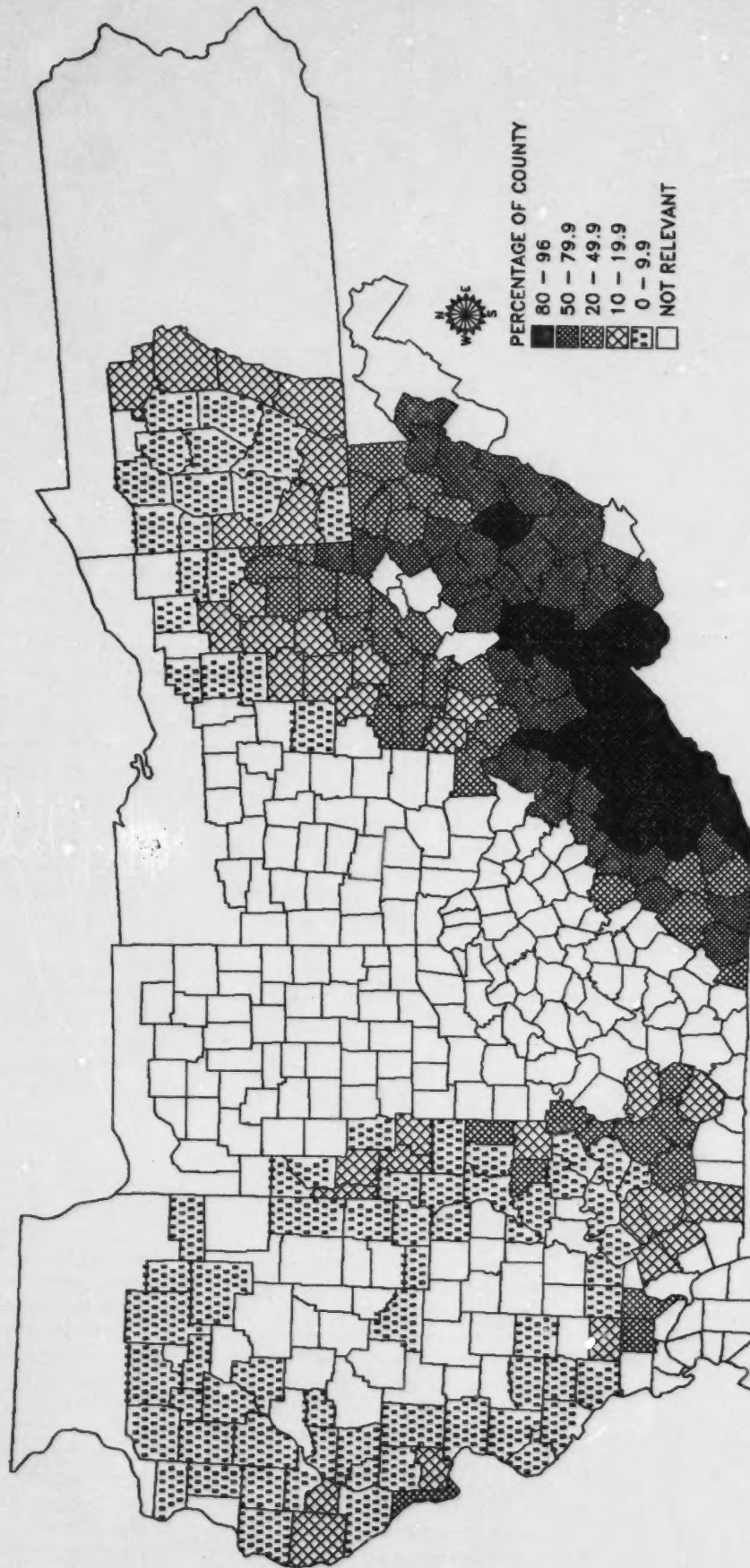


PREPARED FOR OHIO RIVER BASIN ENERGY STUDY
BY CAGS/UKCC, FEBRUARY, 1980

Sources: the most recent Conservation Needs Inventory for each of the six states

Figure 7-2

PROBLEM LANDS: LAND CAPABILITY CLASSES 7 & 8



represent rock outcrops and extremely stony glaciated land. In the western portion of the ORBES region, Class 7 and 8 lands may be river bottom wetlands subject to annual flooding. In most cases Class 7 and 8 lands are wooded because any other use is uneconomical. In the eastern portion of the ORBES region some of these lands have been converted to pasture by land owners lacking more suitable lands for pasture development.

Flat Lands: 0-2.5% Slope (Figure 7-3)

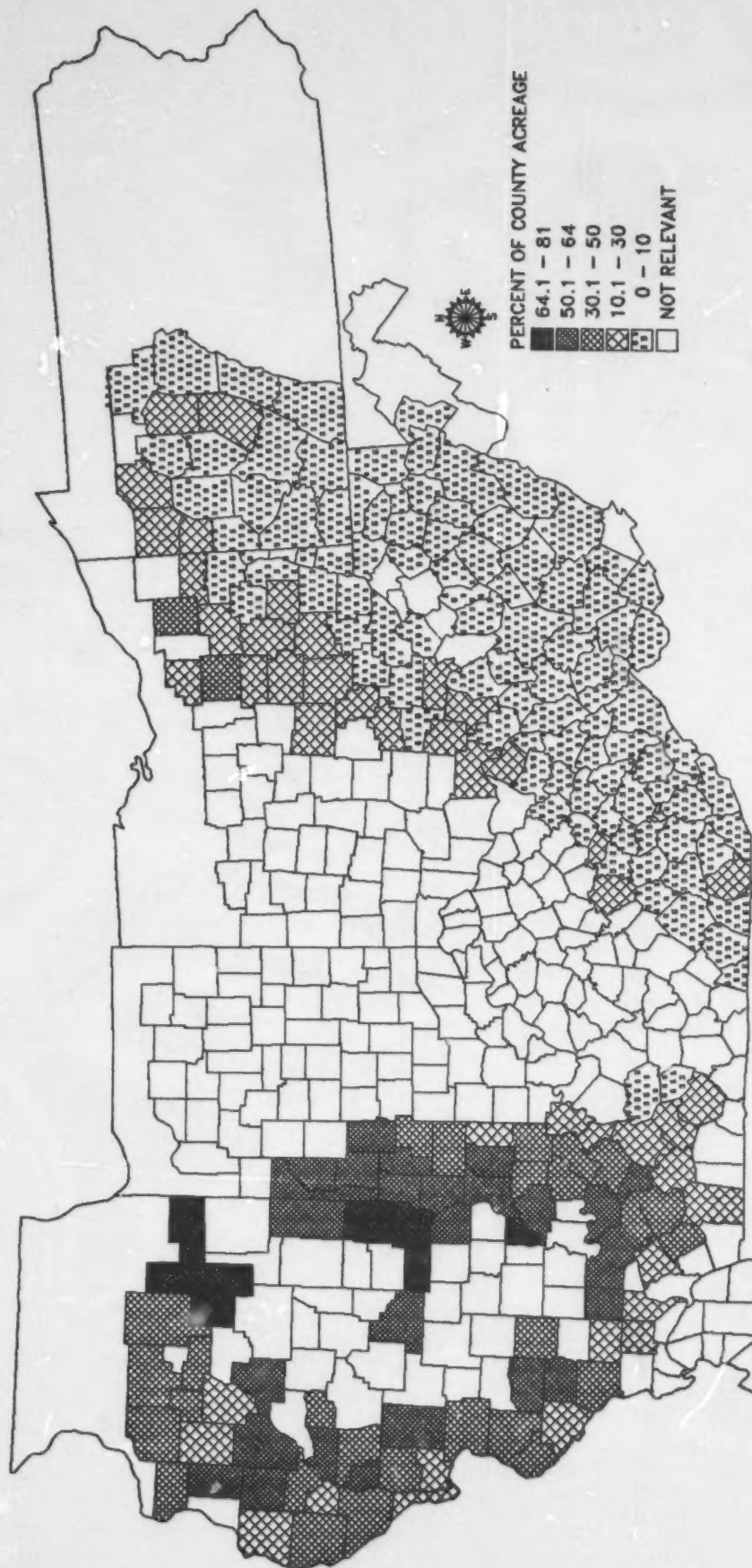
These lands tend to be Prime Farmlands and as such include Class 1 lands. However, these lands may have soils of low permeability, or soils subject to periodic flooding. Row crop agriculture is by far the predominant use of these lands.

Steep Slope Lands: >25%, >30% Slope Depending on State (Figure 7-4)

These lands are steeply sloping as stated. The slopes tend to be wooded, but can support pasture at the more level end of reference (i.e., e.g., nearer to 25% slope than 40% slope). These lands probably give a conservative estimate of forestation, particularly in southeastern Ohio and western Pennsylvania. All of these lands fall under the Steep Slope Provisions of the SMCRA.

Figure 7-3

FLAT LANDS: 0 - 2.5 PERCENT SLOPE

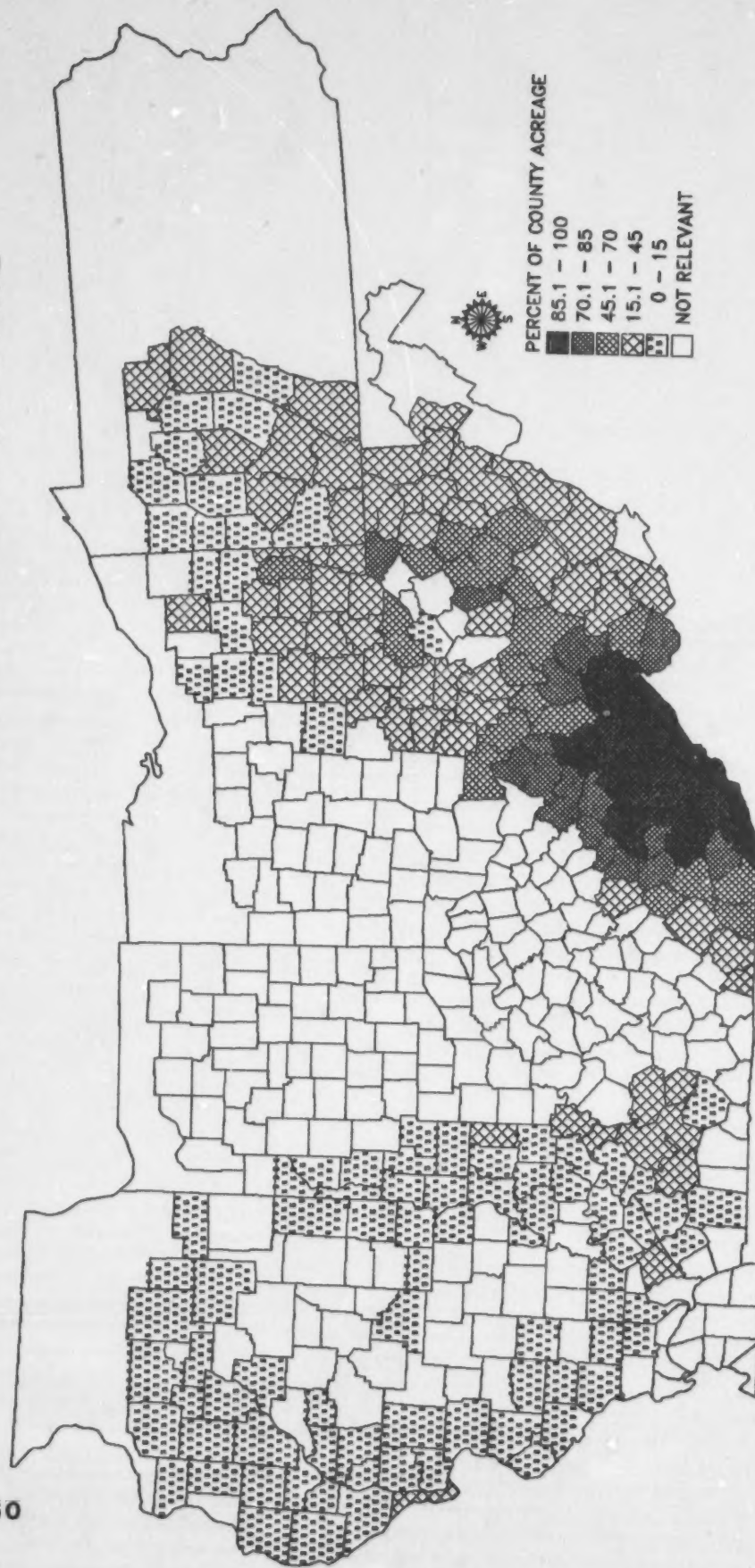


Sources: Lee et al., 1976; Purdue University et al., 1971; Runge et al., 1969; Conservation Needs Inventory Data Bank (computer printout of 1967 slope data for Kentucky, Ohio, and Pennsylvania)

Figure 7-4

STEEP SLOPE LANDS: OVER 25 PERCENT, OVER 30 PERCENT SLOPE DEPENDING ON STATE

60



8. APPLICATION OF ORBES SCENARIOS: FUTURE COAL PRODUCTION FOR ALL PURPOSES

Introduction

This is the first of two chapters pertaining to individual ORBES scenarios. The scenario identification used here refers to the list provided in the ORBES Memorandum dated 16 November 1979, which includes Scenarios #1 through #6 and their various subsets.

For general readers of this report, Scenario #1 tests moderately high energy demand and strict environmental controls. Scenario #2 tests moderately high energy demand and moderate environmental controls. Scenario #2a tests high energy demand involving additional energy for export as generated electricity. Scenario #3 tests low coal-produced energy demand and moderate environmental controls. Scenario #1 and #2 have their coal demands to supply power plants fairly evenly distributed among the ORBES states, but with moderately dispersed (Scenario #1) or conventionally concentrated (Scenario #2) siting patterns of individual power plants among the states. Scenario #2a is an electrical power export scenario, which resembles Scenario #2 in western ORBES, but which includes massive increases in generating capacity in Ohio and modest increases Kentucky-east, Pennsylvania and West Virginia. From the standpoint of land use impacts from surface mining, these scenarios represent cases from low impact to worst case considering all scenarios developed prior to 24 October 1979 (i.e., exclude Scenario #7). As presented in the following sections (Prime Farmlands Conflicts, Steep Slopes Conflicts), the net impact indices did not vary appreciably from one scenario to the next (e.g., Table 9-5). Thus, no other scenarios were assessed, and our complex process of indicating county land use impacts was complete. In the 16 November 1979 list of scenarios, Scenarios #1c (Agricultural Lands Protection) and #5a (Very High Growth in Generating Capacity) may influence land use in patterns by shifting the impact index (e.g., Scenario #1c) or increasing the magnitude of the worst case (e.g., Scenario #5a).

Total Surface Production for each scenario is defined as coal produced for all purposes, one of these purposes being generation of electricity. In this chapter analysis of mining impacts on land use is limited to summation of affected acreage. For general interpretation one may assume that surface uses are non-productive for a two-year period following mining, but that a return to some form of productivity will occur in five years. Our objective is to place in perspective our analysis of the impacts of mining utility coal (Chapter 9).

Ratios of Surface to Underground Mining

Coal will be mined by surface and underground methods. Given a total demand for coal, the proportion of this coal which will be surface-mined is the single most sensitive factor in the estimation of land use impacts due to surface mining. Within any state, the greater the fraction to be surface-mined, the greater will be the affected acreage of land, provided one ignores surface slumping of deep mines. Table 8-1 provides several relevant surface to deep tonnage ratios. From the first two number columns it is evident that surface reserves in 1976 were being exploited disproportionately more than they occur in nature. The OTA projections predict a gradual decline in surface mining relative to underground mining. Calculations derived from the ORBES Demand Model reflects this trend in the case of large changes (e.g., Indiana, Kentucky-East) except in West Virginia.

Table 8-1 Ratios of Surface to Underground Mining (Annual Tonnage)
(% Surface Mined or Mineable)

	Observed (1976) ¹	Estimated (Reserve Base) ²	Hypothetical (2000)		This Study (year 2000) ⁴
			OTA Low ³	OTA High ³	
Illinois	47%	19%	34%	33%	48%
Indiana	98	16	68	56	52
Kentucky-West	56	31	46	45	58
Kentucky-East	55	27	32	30	30
Ohio	64	17	48	44	60
Pennsylvania	48	5	16	17	45
West Virginia	19	13	17	16	26

¹Adapted to ORBES Region From Walls, 1979.

²Adapted to ORBES Region From Thomson and York, 1975.

³Calculated From U.S. Congress, Office of Technology Assessment, 1979.

⁴Derived from the ORBES Demand Model by approximate reapportionment of Bureau of Mines District Production to the states.

Table 8-2

LAND AFFECTED BY SURFACE MINING FOR COAL
Ratios in Acres per Million Tons

COAL FIELD	<u>THIS STUDY</u> ¹	<u>SCS</u> ² <u>(1979)</u>	<u>Hutchins</u> ³ <u>(1979)</u>	<u>OTA</u> ⁴ <u>(1979)</u>
EASTERN INTERIOR				(5 states)
Illinois	193	260		
Indiana	194	239		
Kentucky-West	194	184		
<u>AVERAGE</u>	<u>194</u>	<u>228</u>		158
APPALACHIAN				
			1975 (PRODUCTION)	Reserve (Base) (9 states)
Kentucky-East	458	638	198	158
Ohio	428	472	168	149
Pennsylvania	378 ⁵	434	183	163
West Virginia	370	339	154	142
<u>AVERAGE</u>	<u>408</u>	<u>471</u>	<u>176</u>	<u>153</u>
				376

¹Derived from Table 5-4 (see text for further explanation).

²Land area adapted to the ORBES Region from U.S.D.A. Soil Conservation Service (1979); Tonnage calculations from this study.

³Calculated from Hutchins (1979), pp 62 and 66.

⁴Calculated from U.S. Congress, Office of Technology Assessment (1979), p. 246.

⁵Extrapolated from adjacent counties in Ohio and West Virginia.

Ratios of Land Area to Production

Table 8-2 provides ratios of Land Area to Production. The derivation and plausibility of the ratios in general are discussed in Chapter 5. The ratios used for Scenario calculations are listed in the lefthand column. These ratios are the same as the 1971-1975 period ratios of Table 5-4 except for Kentucky-West. We judge Kentucky-West to be similar to Indiana and Illinois in most respects (e.g., topography, mine size) although the mined seams are slightly thicker (Table 5-3). From the standpoint of overall coal field averages the ratios used for Scenario calculations fall between the calculations based on SCS and OTA data.

Land Area Affected by Total Surface Production

Table 8-3 provides estimates of total cumulative affected acreages over the 25 year scenario period. The acreages involved in the four Scenarios exceed the historical grand total affected acreage of the ORBES region (1.86 billion acres through 1977, U.S.D.A., S.C.S., 1979) by 20% (Scenario #3) to 32% (Scenario #2a). The apportionment of affected acreage to coal basin is 22% Eastern Interior and 78% Appalachian. Much of the difference between coal fields results from the higher acreage to production ratios in the Appalachian Coal Field.

Table 8-4 concerns recently affected land. Such land will be at various stages of recent disturbance starting with clearing for mining, then mining, and ending with recent reclamation. Vegetative cover will vary from barren to row crop and first-year field. No trees will be present unless small ones have been planted. During this period the regional differences in ground cover are reduced to a minimum. In eastern Kentucky and West Virginia, this period is to be one of deforestation. In rough terms the rate of impact is comparable to 1/3 to 2/3 of a county every two years. The Scenario #3 rate of impact is 25% above 1976 in the year 2000; Scenario #2a is 59% above the 1976 rate.

Table 8-3 Cumulative Acreage Affected by Surface Mining of Coal for All Uses: 1976-2000

	<u>Scenario #1</u>	<u>Scenario #2</u>	<u>Scenario #2a</u>	<u>Scenario #3</u>
Illinois	184,000	182,000	194,000	166,000
Indiana	137,000	135,000	143,000	125,000
Kentucky-West	187,000	185,000	196,000	169,000
Kentucky-East	565,000	560,000	586,000	521,000
Ohio	426,000	421,000	447,000	384,000
Pennsylvania	515,000	508,000	539,000	464,000
West Virginia	<u>328,000</u>	<u>325,000</u>	<u>348,000</u>	<u>393,000</u>
TOTAL	2,342,000	2,316,000	2,453,000	2,222,000
% of Total ORBES Region	1.92	1.90	2.01	1.82

Table 8-4 Two-Year Accumulated Total Acreage of Recently Mined Land
at About Year 2000, and Comparison with the 1976 Estimate

	<u>Scenario #1</u>	<u>Scenario #2</u>	<u>Scenario #2a</u>	<u>Scenario #3</u>
Illinois	19,000	19,000	20,000	16,000
Indiana	12,000	12,000	13,000	10,000
Kentucky-West	19,000	18,000	20,000	16,000
Kentucky-East	44,000	43,000	47,000	37,000
Ohio	42,000	42,000	46,000	36,000
Pennsylvania	51,000	50,000	54,000	43,000
West Virginia	37,000	36,000	40,000	31,000
TOTAL (Year 2000)	224,000	220,000	240,000	189,000
TOTAL (Year 1976)	151,000	151,000	151,000	151,000

9. APPLICATION OF ORBES SCENARIOS: COAL PRODUCTION FOR ORBES SCENARIOS POWER PLANTS

Introduction

This section deals with a selected group of interactions between the land surface and coal demand by coal-fired power plants. The specifications for the power plants were provided by the ORBES Core Team. We make several strict assumptions in estimating land involvement. These assumptions have been supplied by the ORBES Core Team and the initial products of this Support Study. Understanding the assumptions will aid the reader to understand the acreage demand estimates and assess their validity.

Our analysis requires the following assumptions.

- a) The heat value of coal for all ORBES coal-fired power plants is 12,450 btu per pound.
- b) The thermal efficiency of these power plants in converting coal energy into electrical energy is 0.343.
- c) The operating capacity factor of these power plants is 50 percent of the maximum load capability.
- d) The operating lifetime of these power plants is 35 years from the date of coming on line.

Thus, an ORBES 650 MWe "standard" coal-fired power plant uses 1.14 million tons annually, or 17.1 million tons in 15 years (e.g., 1985-2000, the Scenario Addition Period as explained below).

We calculated how much land one 650 MWe power plant supplied entirely with surface-mined coal from a given state would use in the course of 15 years. Using the tonnage to acreage surface relationship developed in Chapters 5 and 8, the estimates for each ORBES State/Coal Region is provided in Table 9-1. The land affected will vary from 3,300 to 7,800 acres, which equals 1/7 to close to one third of a standard 6 mi. x 6 mi. township, depending on the state.

Table 9-1 Acres of Land Affected to Fulfill Coal Demand for One 650 MWe Power Plant Supplied Entirely by Surface-Mined Coal and Operating Throughout the Scenario Addition Period of 15 Years

<u>Coal Region, State</u>	<u>Acres Per Million Tons</u>	<u>Cumulative Acreage (Annual Demand = 1.14 Million Tons)</u>
Eastern Interior		
Illinois	193	3,300
Indiana	194	3,317
Kentucky-West	194	3,317
Appalachian		
Kentucky-East	458	7,832
Ohio	428	7,319
Pennsylvania	378	6,464
West Virginia	370	6,327

To estimate the net demand for surface-mined coal by all power plants for a given ORBES scenario, we have characterized power plants between 1976 and 2000 into three groups with one subgroup. The relationship of these groups to coal demand is provided in Table 9-2. The groups represent Existing, Planned, and Scenario Additions. Existing power plants are operating today, Planned power plants are under construction or announced by electrical utility companies, and Scenario Addition power plants are estimates of units necessary to fill electrical demand in the year 2000. Planned power plants are to come on line between 1976 and 1993. The first Scenario Addition power plants will begin generating in 1985; others will follow with the last facilities scheduled for 2000. ORBES assumes that all of the coal-fired power plants will use ORBES coal except in the very few cases where it is definitely known that coal for Existing power plants is imported (e.g., from Virginia and the Western Coal Field). Given this assumption, additional assumptions apply to each of the three different groups of power plants.

a) For Existing power plants there are published data (summarized by ORBES Core Team, Blome memo 8/31/79 a) listing the states of origin of coal shipped to them. Neither the counties of the origin nor the mining methods have been included. Thus, for the present project we summed (the coal supplies) according to state or origin for all power plants existing in 1976. To estimate the portion of coal supplied by surface mining we multiplied the total

Table 9-2 Several Variables Involved in the Estimation of Surface-Mined Coal Demand by ORBES Power Plants.
(See text for additional explanation).

Variable	Existing Power Plants	Existing Power Plants (SIP)	Planned Power Plants	Scenario Addition Power Plants
MWe per unit	Variable as stated	Variable as stated	Variable as stated	650
Maximum time span of operation	1976 - 2000	1976 - 2000	1976 - 2000	1986 - 2000
Unit time span of operation	1976 - decommissioning (1976 - <2000)	1976 - decommissioning (1976 - < 2000)	start up - 2000 [(1976-1993) - 2000]	start up - 2000 [(1986-2000) - 2000]
Origin of coal supply	state(s) as published	state, county (Appalachian Coal Field)	state, county (home state)	state, county (home state)
Mining method	estimated from 1976 state proportions (surface vs. underground)	as stated	as stated	as stated
Annual coal volume per 650 MWe (Million tons)	1.14	1.14	1.14	1.14

tonnages for each given state by the surface to total production fraction for that state in 1976 (see Table 8-1). At first approximation these totals give a single year of surface-mined coal supply by state at 1.14 million tons of coal per 650 MWe generating station.

To estimate the cumulative coal supply for each power plant over several years (1976-2000) we allowed an active power plant lifetime of 35 years and projected the date of decommissioning from the published starting date (data supplied by ORBES Core Team; Jansen, 1978). The state ratios of surface-mined to total production were held constant at 1976 proportions through the year 2000.

b) Certain Existing power plants have a requirement for SIP coal (low sulfur coal). SIP requirements take effect in 1985 and continue for the active life of the given power plant. The ORBES Core Team (Blome memo, 8/31/79 b) has provided the state, county, and mining method for production of SIP coal. Generally, power plants in Illinois, Indiana, and Kentucky are to receive SIP coal from Kentucky-East; power plants in Ohio and West Virginia get SIP coal from West Virginia; and Pennsylvania power plants get SIP coal from Pennsylvania. In certain computations of coal demand for Existing power plants, SIP coal appears as excess coal. To correct for this we subtracted the excess tonnage from the home state coal supplies. (Note: In Kentucky, SIP coal from Kentucky-East replaces non-SIP coal from Kentucky-West).

c) For Planned power plants the ORBES Core Team (Blome memo, August, 1979) has furnished coal supplies according to state, county, and method of mining. Some of the tonnages were assigned to announced mine openings or expansions as listed in Walls et al. (1979). Other supplies come from conjured mines. All supplies originate within the home state of the power plant. Coal demand is 1.14 million tons per year per 650 MWe of power generation.

d) For Scenario Addition power plants, the ORBES Core Team (Blome memo, 8/31/79 c) has furnished coal supplies according to state, county and method of mining. All supplies originate within the home state of the power plant. Coal demand is 1.14 million tons per year for each 650 MWe power plant unit.

We have emphasized surface-mined coal. Underground-mined coal has been omitted from calculation through the aforementioned processes, but is shown in Table 9-3. In relation to both surface and underground coal demand by all ORBES coal fired power plants, surface-mined coal demand represents only 43% of Total Utility Coal Demand for the period 1976-2000, and underground-mined coal represents the remainder.

Table 9-3 Cumulative Coal Demand, 1976-2000, According to Scenario #2 (the base case):
A Comparison of Total Coal Demand for All Uses and for ORBES Power Plants

	Eastern Interior Basin			Appalachian Basin			Total
	IL	IN	KY-W	KY-E	OH	PA	
Total Coal Demand for All Uses							
Underground Mined Million Tons	1,051	355	735	1,860	612	1,503	8,990
%	53	34	44	60	38	53	56
Surface Mined Million Tons	943	698	952	1,222	983	1,345	7,022
%	47	66	56	40	62	47	44
Total	1,994	1,053	1,687	3,082	1,595	2,848	16,012
Electrical Utility Coal Demand							
Underground Mined Million Tons	412	414	309	168	301	546	2,796
%	62	54	47	30	45	69	57
Surface Mined Million Tons	254	345	351	391	372	241	2,115
%	38	46	53	70	55	31	43
Total	666	759	660	559	673	787	4,911
Utility Coal as % of Coal for All Uses	33	72	39	18	42	28	31

Affected Lands

Table 9-4 summarizes the results of our coal demand calculations predicting acreages of land to be affected within the states. This table also distinguishes between acreages subdivisible to the county level and acreages not so specifically locatable. Only about one-half of the affected acreages can be assigned to counties under each of the three scenarios. This results because existing power plants need a large proportion of the coal, and the sources of this coal have not usually been traced to county during the course of this study.

In no case does the coal demand as reflected in affected acreages constitute half of the total projected surface mining activity within the ORBES region (Chapter 8). The excess coal will be exported and that the remainder will be used for purposes other than electrical power generation (e.g., coking) (Core Team).

Table 9-5 gives acreages affected at the county level. We have listed these as the maximum and minimum amounts drawn from any of the three scenarios. The center column gives the power plant category: S = SIP, P = Planned, C = Conjured, (R) = Reserves for Existing power plants. The category (R) is not associated with finite acreages since Existing power plants do not have coal supply counties assigned to them (for other than SIP coal). Category (R) counties do, however, have large surface reserves, and with few exceptions (e.g., Henderson, Kentucky) support large surface mine industries capable of supplying existing power plants. We have listed category (R) counties to give balance to total set of counties used in import evaluation (two right-hand columns in Table 9-5).

Interactions Between Surface Mining, Prime Farmlands, and Steep Slopes

The Surface Coal Mining and Reclamation Operations Permanent Regulatory Program (U.S. Department of Interior, Office of Surface Mining, 1979) gives special recognition to the mining of Prime Farmlands and Steep Slopes (Slopes >20%) making reclamation more difficult and costly for these land forms than for several other types of land. For mining of Prime Farmlands, diesel scrapers must collect and stockpile the soil in two separate constituents representing the A horizon and the B, or B plus C horizons. After mining, the company must level the spoils, replace the B/C horizon, then the A horizon on top, and demonstrate through planting and harvest that high quality agricultural capability has been restored to the land. Thus, the economic potential for future land use is clearly implied within the law.

The constraints governing mining of Steep Slopes can render surface mining uneconomical where economic conditions prevailed formerly. Productivity or economic return from reclaimed steep slopes does not appear to be a significant issue legally. In terms of actual or potential land use, steep slope lands are forested lands or are recommended for forestation (except in

Table 9-4.

Scenario Acreages: Cumulative Acreages Which Would be Affected by Surface Mining For Coal
For the 1976-2000 Period, and County Coal Mine Siting Information.

72

Scenario and County Siting Information	Eastern Interior Coal Field State				Appalachian Coal Field State				WV	ORBES TOTAL	%
	IL	IN	Ky-W	Ky-E	OH	PA					
Acres per million tons	193	194	194	458	428	378			370		
Scenario #1											
Sited to counties	22,000	26,000	50,000	109,000	67,000	19,000			30,000	323,000	49
Not sited to counties	24,000	38,000	18,000	71,000	91,000	71,000			29,000	342,000	51
Total	46,000	64,000	68,000	180,000	158,000	90,000			59,000	665,000	100
Scenario #2											
Sited to counties	25,000	29,000	50,000	108,000	68,000	20,000			31,000	331,000	49
Not sited to counties	24,000	38,000	18,000	71,000	91,000	71,000			29,000	342,000	51
Total	49,000	67,000	68,000	179,000	159,000	91,000			60,000	673,000	100
Scenario #2a											
Sited to counties	24,000	29,000	50,000	118,000	116,000	17,000			31,000	385,000	53
Not sited to counties	24,000	38,000	18,000	71,000	91,000	71,000			29,000	342,000	47
Total	48,000	67,000	68,000	189,000	207,000	98,000			60,000	727,000	100
Scenario #3											
Sited to counties	19,000	26,000	48,000	93,000	58,000	9,000			27,000	280,000	45
Not sited to counties	24,000	38,000	18,000	71,000	91,000	71,000			29,000	342,000	55
Total	43,000	64,000	66,000	164,000	149,000	80,000			56,000	622,000	100

Table 9-5

**Surface Mine Counties for ORBES Scenarios,
Range in Estimated Mine Acreage, and Land Use
Impact Indices for the Mines**

State County	Affected Acreage		Power Plant Category Supplied	Impact Indices	
	Maximum	Minimum		Prime Farmlands	Steep Slopes
IL					
Fulton	1,700	0	C	++++	0
Greene	--	-	(R)	++++	0
Grundy	--	-	(R)	++++	0
Henry	--	-	(R)	++++	0
Jackson	7,200	7,200	P	++++	0
Knox	3,200	3,200	P	++++	0
Madison	--	-	(R)	++	0
Peoria	300	0	C	++++	0
Perry	-	-	(R)	++	0
Randolph	8,100	8,100	C	++	0
Saline	-	-	(R)	++++	0
Stark	4,100	4,100	C	++++	0
St. Clair	-	-	(R)	++++	0
Vermilion	-	-	(R)	+++	0
Williamson	-	-	(R)	++++	0
IN					
Clay	1,500	900	C	++++	0
Daviess	5,200	5,200	P	+++	0
Fountain	1,600	1,600	P	+++	0
Knox	2,000	0	C	+++	0
Pike	5,800	5,800	P	+++	0
Sullivan	6,900	5,100	P,C	+++	0
Warrick	6,700	6,100	P,C	++	0
KY-W					
Butler	9,900	9,900	P	+	+
Daviess	10,900	10,900	P	++++	0
Henderson	-	-	(R)	+++	0
Hopkins	5,900	5,300	P,C	++	0
Muhlenberg	14,600	14,600	P	+	0
Ohio	5,600	5,600	P,C	+	+
Union	2,900	2,900	P	+++	0
KY-E					
Bell	12,300	12,300	S	0	++++
Breathitt	44,000	44,000	S,C	0	++++
Clay	4,100	4,100	P	0	++++
Harlan	-	-	(R)	0	++++
Johnson	5,700	5,700	P	0	++++
Leslie	19,000	8,900	S,C	0	++++
Letcher	3,400	3,400	S	0	++++
Magoffin	2,400	2,400	S	0	++++
Martin	15,800	15,800	P	0	++++
Perry	10,500	10,500	S	0	++++
Pike	800	800	S	0	++++

State County	Affected Acreage		Power Plant Category Supplied	Impact	Indices ¹
	Maximum	Minimum		Prime Farmlands	Steep Slopes
OH					
Athens	13,100	3,400	P,C	+	++
Belmont	6,400	1,300	C	+	+
Carroll	600	0	C	+	0
Columbiana	6,400	3,200	C	++	+
Coshacton	25,300	25,300	P	+	0
Harrison	7,700	4,500	C	0	0
Jefferson	9,600	0	C	0	+
Muskingum	5,100	1,300	C	+	0
Noble	-	-	(R)	+	+
Perry	9,600	7,100	C	++	0
Stark	9,000	0	C	+++	0
Tuscarawas	19,500	9,800	P,C	+	0
Vinton	7,100	0	C	0	++
PA					
Armstrong	-	-	(R)	+	+
Beaver	4,700	4,700	P	+	+
Butler	5,700	1,500	C	+	0
Clarion	-	-	(R)	++	0
Clearfield	13,700	8,200	S,C	+	+
WV					
Boone	2,600	2,600	S	0	++++
Fayette	600	0	C	+	+++
Kanawha	24,400	21,700	S,C	0	++++
Logan	-	-	(R)	0	++++
McDowell	-	-	(R)	0	++++
Mingo	1,100	0	C	0	++++
Raleigh	-	-	(R)	+	+++
Wayne	3,700	3,700	P	0	+++

Sources for Determination of Impact Indices: Agricultural and Industrial Board of Kentucky, 1953; Brant, 1956; Bureau and Powell, 1974; Callahan and Callahan, 1971; Christman et al., 1971; Conservation Needs Inventory Data Bank, 1967; Couchot, 1978; Council on Environmental Quality, 1973; Cox, 1974; DeLong, 1955, 1978; DeLong and White, 1963; Hayhurst et al., 1974; Heard, 1979; Kelley, 1974, 1975; Kentucky Department of Commerce, Division of Research and Planning, 1975; Lamborn, 1956; Lee et al., 1976; Lessig et al., 1968, 1977; Mausel et al., 1975; Montgomery, 1974; Mullins et al., 1963, 1965, 1969; Ohio Soil and Water Conservation Needs Committee, 1971; Paschall et al., 1938 a, b; Pennsylvania Conservation Needs Inventory Committee, 1968; Powell, 1976; Purdue University et al., 1971; Rubel et al., 1979; Runge et al., 1969; Sholes and Skema, 1974; Shumate and Lessig, 1976; Smith et al., 1952; Smith and Stall, 1975; Spencer, 1953; Thomson and York, 1975; Treworthy et al., 1978; USDA-SCS, 1977, 1979; USDA-SCS et al., 1975; USDI-GS, 1969 a, b, c, 1972 a, b, 1976, 1977 a, b; University of Illinois Agricultural Experimental Station, 1977; Weir, 1953; Weir and Deane, 1958; Weir and Stanley, 1953; West Virginia Conservation Needs Inventory Committee, 1970; Whitmore, no date.

exceptional cases, e.g, ski resorts). Steep slopes today are largely forested as can be demonstrated through overlays of land form and land use maps from the U.S. National Atlas. However, the quality of the forests varies appreciably as a result of varied harvesting practices, poor restocking, natural species composition, and antiquated surface-mining practices. An appropriate map quantifying forest quality (mostly by tree size and wood volume rather than species composition) is available in the document, National Coal Utilization Assessment (Oak Ridge National Laboratory, 1978). In the ORBES region steep slopes constitute a large, if not the largest subset of Class 7 and 8 lands defined by the U.S. Soil Conservation Service, which this authority recommends for commercial, recreational or wildlife oriented forestation (see any SCS state Soil and Water Conservation Needs Inventory for a description). Thus, as a summary we assume that mining of steep slopes will influence future forestry more than any other form of land use.

We selected Prime Farmlands and Steep Slopes for quantitative assessment primarily because of their special mention in the USDI, OSM Surface Mining Regulations. Also, we had a broad, although uneven, data base available to allow analyses of these land use associated issues. With other issues, interactions with mining activity would be much more speculative. Interestingly, Prime Farmlands and Steep Slopes represent conflicts between the mining company, the government, and the surface rights owner. Surface mining continues to be a source of impact to the surface conditions while reclamation standards inhibit the mining company.

Conflict Indices: We adopted a five-point scale (0-++++, or 0-4) to evaluate potential interactions between surface mining, Prime Farmlands and Steep Slopes (Table 9-5, righthand columns). We interpret the points on the scale as having the following approximate significance:

- 0 unlikely, although possible, but having significance only to a few individuals locally
- + probable, but having significance only locally within a county
- ++ probable and having widespread significance within a county depending on the total acreage disturbed
- +++ highly probable and having significance beyond county borders depending on the total acreage disturbed
- ++++ highly probable and having national significance

We developed our county assessments depending on evidence that strippable coal reserves underlie Prime Farmlands or Steep Slopes. Such evidences are documented with Table 9-5. They include maps of coal deposits, coal outcrops, strippable reserves, mined-out areas, prime farmlands, county soil surveys, surface contours, and slope angle areas. For several counties the relationship between slope angle and reserves has been assessed in a form directly applicable to our study (e.g., Council on Environmental Quality, 1973). We also used our computer printout of slope frequency data from the 1967 Conservation Needs Inventory Data Bank as a crosscheck against the contour maps. Figures 9-1 and 9-2 give locations of Prime Farmland and Steep Slope conflicts, respectively.

The quality of our data varies from state to state and county to county. Illinois data are best with a recent survey of economically strippable reserves, a prime farmland map, and a regional rating of prime farmlands separating the very best from good. Indiana and Kentucky-West have coal deposit maps with coal seam structural contours and mined-out areas shown. Assessment of the Appalachian Coal Field required examination of individual documents about counties, often containing outdated or presumably outdated information.

We used the conflict indices to contrast Scenarios (Table 9-6), one Power Plant category with another (Table 9-7), and one state with another (Tables 9-8 and 9-9). For each estimate we weighted the index using the acreages involved at the county levels and then divided by the total affected acreage within the category assessed (e.g., all Scenario #1 affected acreage). Thus, a categorical calculation becomes the sum of affected county acreages multiplied by respective county indices then divided by the total sum of affected acreages. For Existing Power Plants we used a slightly different system of weighting. We set the 1976 surface production by the counties in Table 9-4 proportional to the surface mined coal demand for Existing Power Plants within each home state, scaled each county production figure by the county conflict index, and then divided by the aforementioned state coal demand for Existing Power Plants. We used this form of estimation to offset the lack of definite county data on coal demand for Existing Power Plants.

Table 9-10 summarizes Scenario coal demand according to each level of the conflict scale. The data used in developing this table are identical to the data used in constructing the aforementioned tables except that we deleted affected acreage as a variable. This table ranks coal tonnage according to the constraints limiting mining. The table provides the mineral interest view as opposed to the surface land use view of the conflict between the two issues. That is, it shows how much coal is associated with a given level of constraint which could increase the cost of extraction.

We can summarize our findings briefly. The net Prime Farmland indices for each of the Scenarios is only about one (Table 9-6). This supports the view that modification of Prime Farmlands through surface mining is mostly a local issue as opposed to a national one. It has become a national issue

CONFLICT RATING: PRIME FARMLANDS VS. SURFACE RESERVES

Figure 9-1

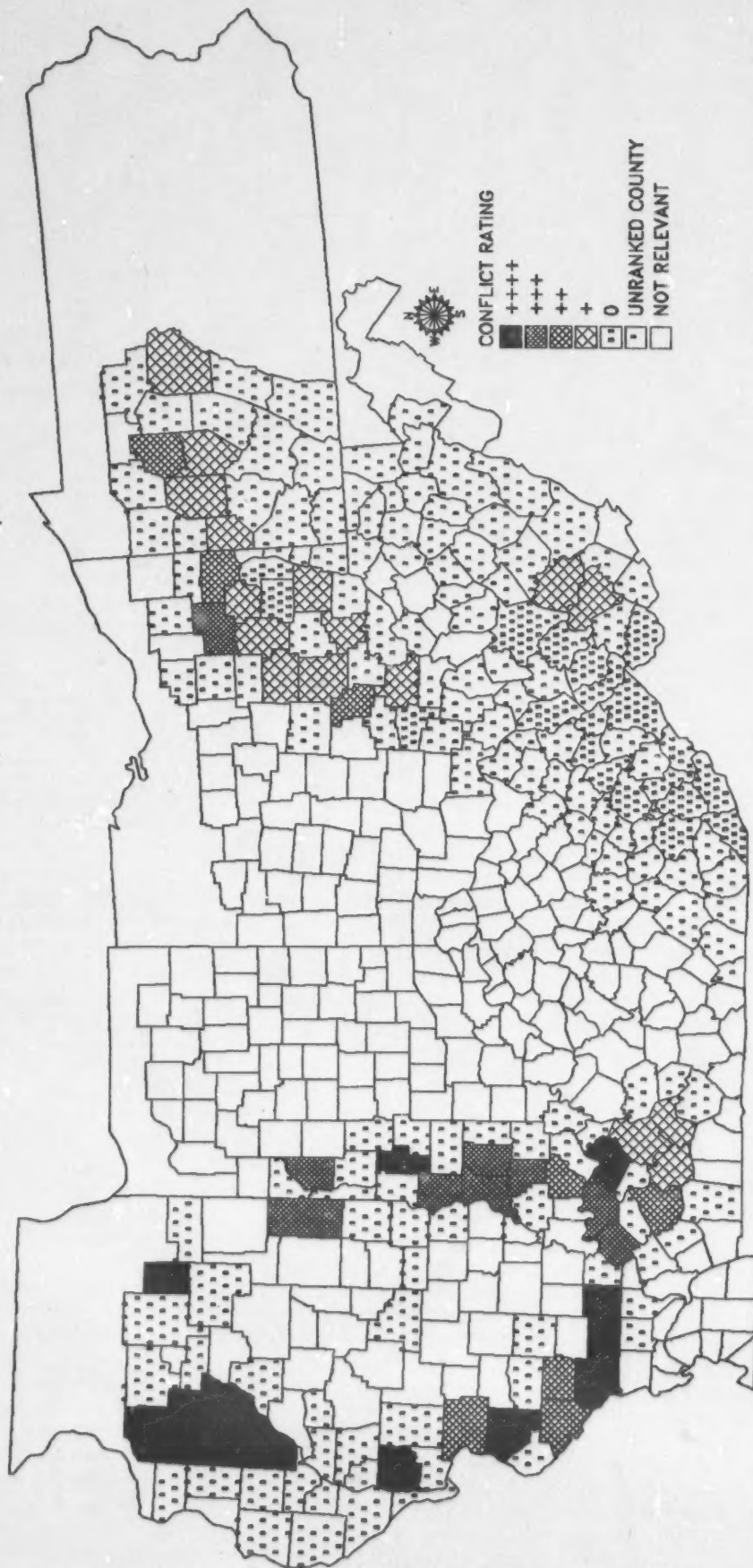
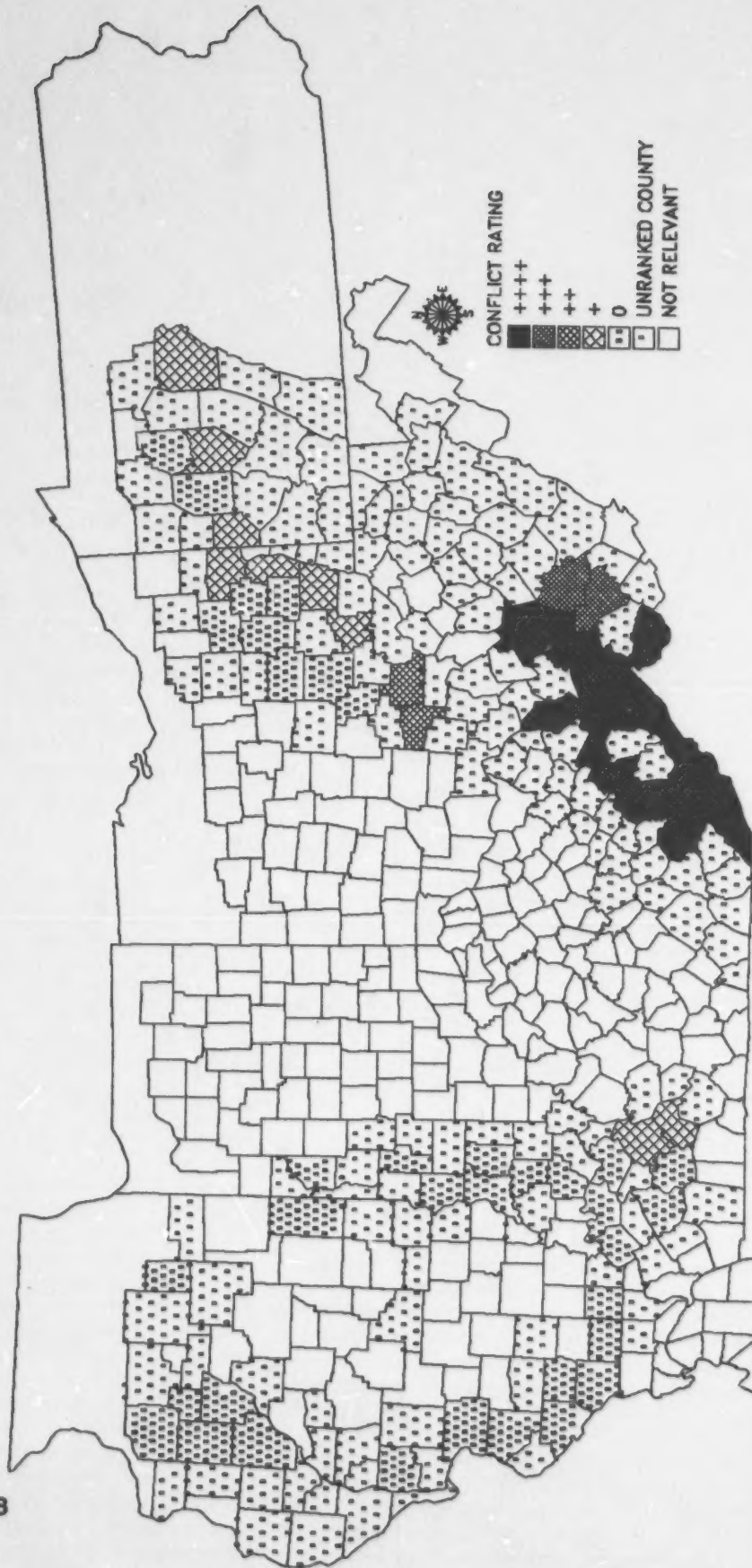


Figure 9-2

CONFLICT RATING: STEEP SLOPES VS. SURFACE RESERVES

78



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BY CAGIS/UIC, FEBRUARY, 1980

Sources: see Table 9-5 (bottom) for listing

Table 9-6 The Net Impact of Three Scenarios on Two Types of Landform in the ORBES Region (ORBES-Wide Impacts Rated on a Scale of 0-4)

Scenario	Acres Required	Prime Farmland Impact	Steep Slope Impact
#1	655,000	1.049	1.602
#2	663,000	1.081	1.618
#2a	717,000	1.048	1.586
#3	622,000	1.063	1.636

Table 9-7 The Net Impact of Three Scenarios on Two Types of Landform in the ORBES Region: Organization According to Power Plant Category (Impact Scale of 0-4).

ORBES-WIDE IMPACTS RATED ON SCALE OF 0-4

Coal Demand Facilities	Acres Required	Prime Farmland Impact	Steep Slope Impact
Existing - Non SIP (All Scenarios)	342,000	1.036	1.443
SIP and Planned (All Scenarios)	225,000	1.042	1.935
Planned Additions:			
Scenario #1	88,000	1.117	1.379
Scenario #2	96,000	1.332	1.460
Scenario #2a	150,000	1.082	1.394
Scenario #3	55,000	1.317	1.609

Table 9-8 Prime Farmland Conflicts: Acres Affected and Impact Indices (Scale = 0-4) According to State and Power Plant Category

80

State	Existing Non - SIP	SIP & Planned (All Scenarios)	Planned Additions			
			Scenario #1	Scenario #2	Scenario #2a	Scenario #3
			Acres Affected			
Illinois	24,000	10,000	12,000	14,000	14,000	9,000
Indiana	38,000	21,000	5,000	8,000	8,000	5,000
Kentucky-West	18,000	47,000	3,000	3,000	3,000	1,000
Kentucky-East	71,000	88,000	11,000	10,000	20,000	5,000
Ohio	91,000	39,000	28,000	30,000	77,000	19,000
Pennsylvania	71,000	6,000	13,000	14,000	11,000	3,000
West Virginia	29,000	14,000	16,000	17,000	17,000	13,000
			Impact Indices			
Illinois	2.709	4.000	2.666	2.857	2.857	2.452
Indiana	2.558	2.778	2.882	2.923	2.923	2.875
Kentucky-West	1.250	1.909	1.556	1.636	1.636	2.000
Kentucky-East	0.000	0.000	0.000	0.000	0.000	0.000
Ohio	0.765	1.000	1.205	1.522	1.083	1.667
Pennsylvania	0.624	1.000	1.000	1.000	1.000	1.000
West Virginia	0.231	0.000	0.034	0.000	0.000	0.000

Table 9-9 Steep Slope Conflicts: Impact Indices (Scale = 0-4) According to State and Power Plant Category¹

State	Existing Non-SIP	SIP & Planned		Planned Additions		
		(All Scenarios)	(All Scenarios)	Scenario #1	Scenario #2	Scenario #2a Scenario #3
Illinois	0.000	0.000	0.000	0.000	0.000	0.000
Indiana	0.000	0.000	0.000	0.000	0.000	0.000
Kentucky-West	0.225	0.308	0.444	0.364	0.364	0.000
Kentucky-East	4.000	4.000	4.000	4.000	4.000	4.000
Ohio	0.572	0.178	0.341	0.783	0.717	0.667
Pennsylvania	0.624	1.000	0.565	0.897	0.869	1.000
West Virginia	3.769	4.000	3.966	4.000	4.000	4.000

¹Acres affected are the same as in Table 9-8.

Table 9-10 Cumulative Coal Demand According to Conflict Scale, Power Plant Category, and Scenario (Volume in Millions of Tons)

Power Plant Category	Prime Farmland Conflict Scale					Net Index
	Low 0	1	2	3	High 4	
Existing	284	354	247	104	60	1.335
Planned and SIP	251	254	44	101	110	1.426
Scenario Additions:						
Scenario #1	76	73	84	8	29	1.400
Scenario #2	61	59	97	27	36	1.706
Scenario #2a	139	87	90	48	36	1.386
Scenario #3	47	23	75	21	11	1.582
Scenario #1 Total	611	681	375	213	199	1.377
Scenario #2 Total	596	667	388	232	206	1.418
Scenario #2a Total	674	695	381	253	206	1.375
Scenario #3 Total	582	631	366	226	181	1.392
Steep Slope Conflict Scale						
	0	1	2	3	4	Net Index
Existing	567	237	11	18	216	1.121
Planned and SIP	411	89	8	0	251	1.461
Scenario Additions:						
Scenario #1	154	48	0	2	66	1.172
Scenario #2	152	42	26	0	60	1.191
Scenario #2a	217	62	39	0	82	1.172
Scenario #3	102	17	11	0	47	1.282
Scenario #1 Total	1132	374	19	20	533	1.252
Scenario #2 Total	1130	368	45	18	527	1.254
Scenario #2a Total	1195	388	58	18	549	1.247
Scenario #3 Total	1080	343	30	18	514	1.266

because the total acreage of prime farmlands affected throughout the ORBES region and the nation as a whole has amounted to many thousands of acres over the years. However, recognition of surface mine reclamation as a national issue has lagged behind rapid growth in surface mining by several decades. If surface-mineable coal reserves were to have coincided with Prime Farmlands precisely (which they do not; Table 9-5, Figure 9-1) national recognition might have come earlier. Prime Farmlands as a state issue has preceded federal concerns by at least five years (e.g., the Illinois SMLC & R Act, Rule 1104, see Chapter 10, Agricultural Productivity). This historical event is compatible with Table 9-8, which shows Illinois as relatively the most severely impacted state. Provided that federal and state regulations succeed in restoring Prime Farmlands, the temporary removal of these lands from productivity should remain a local issue. The projected level of coal utilization for ORBES power plants provides a liberal estimate of 15,000 acres suspended from production during any given growing season (given four years between the last pre-mining crop and the first post-mining crop of high quality).

Steep Slope indices show higher net values for the Scenarios than do Prime Farmland indices. We attribute this phenomenon to the high demand of the ORBES power plants for low sulfur coal, which is restricted to Steep Slope terrain in the ORBES region. The relatively recent upsurge in surface mining on Steep Slopes (Kentucky-East and West Virginia in Tables 3-1 and 5-4; also Currens and Smith, 1977) and the assured demand for low sulfur coal may have contributed to national concern over Steep Slope mining. As discussed in Chapter 4, the difficulties associated with reclamation of contour stripped Steep Slope lands may favor practice of mountaintop removal where practicable. The affect of this process on most areas will result in increased agricultural utilization of Steep Slope areas. This trend will not create prime farmland for row crop agriculture but rather will increase grazing and hay meadow forms of agriculture.

Alternatively, we have calculated the proportion of coal resource constrained by special requirements for surface mine reclamation. The net impact indices for Prime Farmlands and Steep Slopes are slightly over one for each power plant category and each scenario. The net impact indices of Prime Farmland constraints are slightly higher than those for Steep Slopes. The amount of most highly constrained coal (Scale #4) varies from 9.3 to 9.9% for Prime Farmlands and from 25 to 26% for Steep Slopes according to Scenario. The high conflict category clearly concerns less Prime Farmland coal than Steep Slope coal. We interpret this contrast in relation to the net impact indices for the Scenarios as a function of surface land form interspersion over local blocks of mineable coal. Steep Slopes tend to overlie all of the coal locally whereas Prime Farmlands, lower quality farmlands, and other lands may be interspersed over coal locally.

10. CAPSULE REVIEW OF PAST AND PRESENT RECLAMATION

Introduction

After operators have ceased mining a given parcel of land and have fulfilled their legal requirements for reclamation, the land is called post-mined or an "affected area" and will acquire a post-mining land use. All land has potential use. Actual use may remain largely unknown until documentation during a census of surface-mined lands. Until then, land use is both unknown and unobserved. Following a census, the use may be recorded as "none observed" (e.g., in Haynes and Klimstra, 1975) at which time it becomes safe to speculate that any use is at most light. Reclamation legislation is becoming increasingly stringent because public discontent with early reclamation practices appears to have exceeded public acceptance. In this section we examine some of the evidence concerning potential and actual land use.

Quality of the Data

In our survey we found few comprehensive studies documenting observed post-mining land use on a county or state-wide basis. Observed post-mining land use in an exact sense has been compiled for Illinois only. We were able to extend coverage of the ORBES region through inferential data. Some data were general summaries of the type of grading and/or vegetation on lands from which bond had been released. Kentucky and West Virginia appear to lack summarized land use data, observed or inferred. Both states request a statement about post-mining land use on their surface-mining permit applications. However, inasmuch as this information involves land that has not been mined at the time of application, the level of inference is one step more removed from any census of actual post mining use. Further, the task of analyzing several years of accumulated permits would be large (see Table 3-2), and the entries by prospective mine operators are often casual (Charles F. Peters, personal communication).

To broaden our perspective of old vs. recent methods of reclamation, we visited 34 field sites (Figure 10-1) and two additional active mines.

Lands Mined Prior to 1977

Paone et al. (1974) indicated that the ORBES states are much above the national average in their efforts toward reclamation. In numerical terms the figures suggest that 50-65% of all lands ever used for any form of mining in these states have been reclaimed. They defined "reclaimed" as being in compliance with state laws or as having been restored to a useful condition. The Soil Conservation Service (U.S. Department of Agriculture, 1979) took a different view reporting that percentages of affected lands not needing reclamation are as follows: Illinois, 30%; Indiana, 34%; Kentucky, 37%; Ohio, 36%; Pennsylvania, 40%; and West Virginia, 58%. The discrepancy between the two studies appears to lie in definition of "adequate reclamation." The Paone study accepted as reclaimed lands which met requirements of the reclamation laws in effect at the time of mining. The SCS study required more stringent criteria of either (1) productive utilization at any level of restoration, or (2) reclamation to modern (though not defined) standards. Much of the land requiring reclamation was not covered by any law, and as such remains a nagging problem of the past as opposed to a growing problem of the future.

Data on observed land use are available for Illinois. Table 10-1 tabulates land use on lands mined prior to any laws governing reclamation. Table 10-2 gives land use of lands mined under Illinois' first surface mine law. The largest category in both tables indicates that no active land use was evident at the time of census (38% of pre-1962 acres; 64% of post-1962 lands). The percentages of unused land for both periods is so large that enhancement of land use through active reclamation is not perceived in these data.

One factor, the age of spoils, has allegedly influenced recreational use of surface-mined lands in Illinois. Recreational use tends to favor wooded spoils (Haynes and Klimstra, 1975; Ashby et al., 1978), which are more plentiful and mature on pre-law lands (Table 10-1).

Data on observed land use of pre-1960 lands in Indiana as of 1960 are available in Guernsey (1960). The data for Indiana are less precise than those for Illinois (Haynes and Klimstra, 1975). Some categories of land use have been combined and others have been inferred.

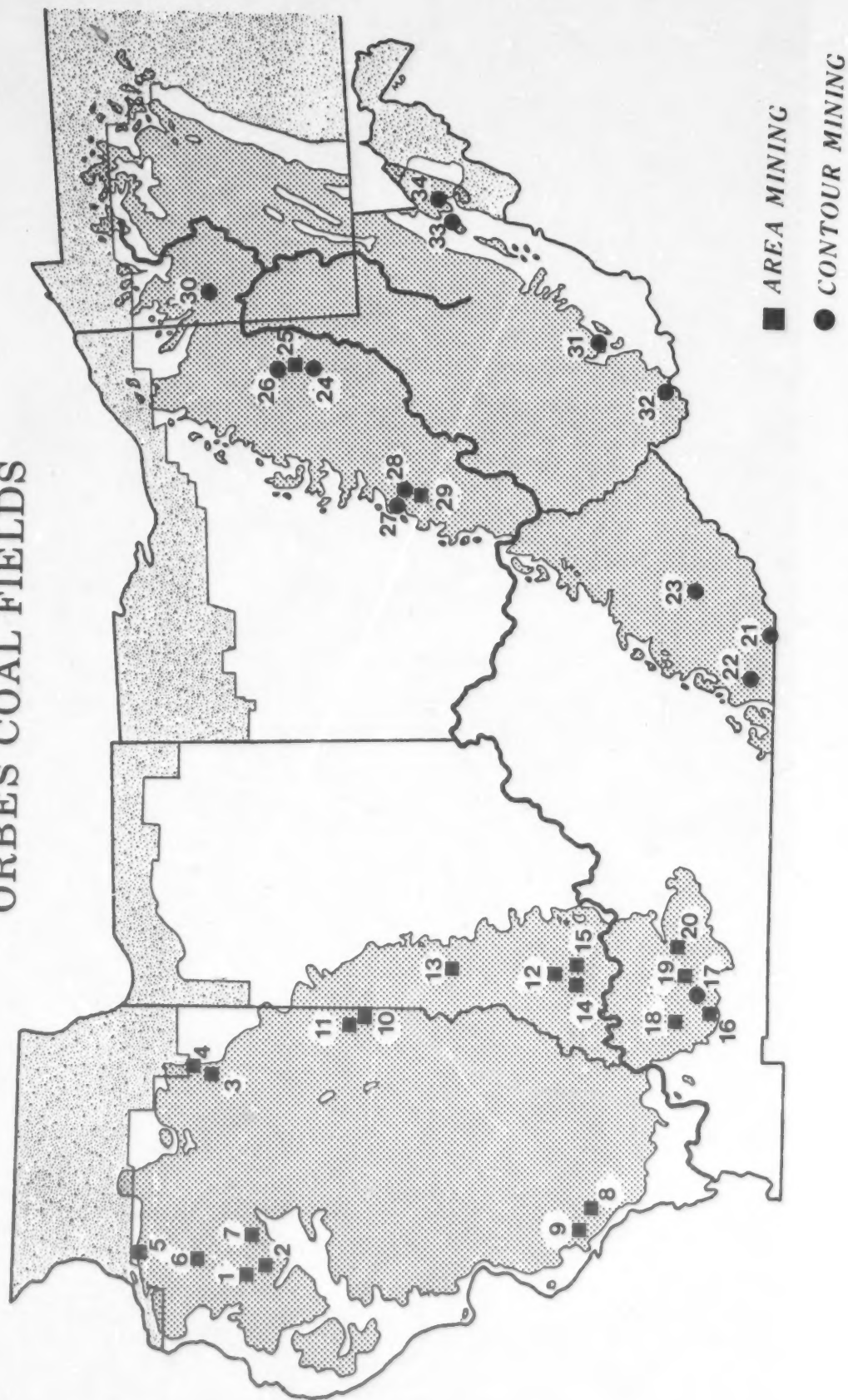
Inferential or potential land use is listed according to dominant type of grading or type of vegetation for several states as follows: Illinois, Table 10-3; Indiana, Tables 10-4 and 10-5; Ohio, Table 10-6; and Pennsylvania, Table 10-7.

On a regional basis, efforts at forestation appear to increase from west to east (Illinois, 30% on old lands, 7% on intermediately aged lands and 5% on recent lands; Indiana, 55% on old lands, 10% on recent lands; Ohio, 60-65% on intermediately aged lands; and Pennsylvania, 82-85% on old and intermediately aged lands). Conversely, potential land use for pasture and hay

OHIO RIVER BASIN ENERGY STUDY PHASE II

Figure 10-1

SURFACE MINE STUDY SITES
ORBES COAL FIELDS



EASTERN INTERIOR BASIN

ORBES Western Coal Field

1	Fiatt
2	Prairie Plan
3	Coal City Club
4	Goose Lake
5	Atkinson
6	Sherwood
7	Banner
8	Pyramid
9	Streamline
10	Harmattan
11	Kickapoo
12	Patoka
13	Greene-Sullivan
14	Lynnville
15	Enos
16	Fox Run
17	Mortons Gap
18	Richland
19	Central City
20	Rockport

APPALACHIAN BASIN

ORBES Eastern Coal Field

21	Log Mountain
22	Beaver Creek
23	Hazard
24	Piedmont
25	Cadiz
26	Harrison Rec. Area
27	Haydenville
28	Minkers Run
29	Valley Coal
30	Moraine
31	Babcock
32	Windmill Gap
33	Alpena Gap
34	Blackwater Falls

Table 10-1

Observed Land Uses on "Pre-Law" (pre-1965) Lands
Surface-Mined for Coal in Illinois^{1,2}

Acres

County	Pasture	Hay	Row Crop	Orchard	Timber	Recreational Lands Organized	Unorganized	Residential	Other Buildings and Roads	Additional Mining	No Land Use Evident	Water Area ³
Adams	0	0	0	0	0	0	0	0	0	0	171	6
Brown	1	0	0	0	0	0	0	0	110	0	872	306
Bureau	1,639	0	0	0	0	0	0	0	0	0	4	0
Clark	0	0	0	0	0	0	0	0	0	0	48	3
Crawford	0	0	0	0	0	0	0	329	34	173	6,047	2,963
Edgar	11,154	1,354	662	45	0	3,171	394	0	0	0	170	7
Fulton	31	0	0	0	0	0	0	0	0	0	27	3
Gallatin	0	0	0	0	0	0	0	1,326	0	0	616	1,143
Greene	0	0	0	0	5	4,240	0	0	0	0	81	4
Grundy	18	0	0	0	0	0	0	21	47	0	580	302
Hancock	953	0	0	0	0	685	8	0	27	0	1,231	130
Henry	2,466	0	0	0	0	77	40	0	0	0	62	9
Jackson	0	0	0	0	0	0	0	0	0	0	1	0
Jefferson	0	0	0	0	0	0	0	0	0	0	618	359
Jersey	0	0	0	0	0	0	0	24	0	30	1,151	1,350
Johnson	180	0	0	0	0	491	377	0	53	0	953	33
Kankakee	8,063	352	23	0	0	1,066	12	0	23	0	0	0
Knox	29	0	0	0	0	3	0	11	0	0	0	0
LaSalle	0	0	0	0	0	0	0	0	0	0	0	0
Livingston	0	0	0	0	0	0	0	0	0	0	0	0
Madison	1	0	0	0	0	0	0	0	0	0	0	2
Marshall	5	0	0	0	0	0	0	0	0	0	0	1
McDonough	0	0	0	0	0	0	0	0	0	0	0	0
Mercer	0	0	0	0	0	0	0	0	0	0	0	0
Morgan	0	0	0	0	0	0	0	0	0	0	0	0
Peoria	674	0	0	80	1,126	4	1	0	51	90	392	58
Perry	2,826	0	0	0	0	2,593	0	0	47	206	5,043	1,083
Pike	0	0	0	0	0	0	0	0	0	0	0	0
Randolph	914	0	0	0	0	0	0	0	0	0	1,286	207
Saline	164	0	0	0	0	27	17	0	6	0	5,170	170
Schuyler	566	0	0	0	0	0	0	0	5	0	648	129
Scott	0	0	0	0	0	0	0	0	0	0	1	0
Stark	150	0	0	0	0	0	0	0	0	0	71	9
St. Clair	2,115	38	0	0	0	485	156	19	11	54	2,458	594
Vermillion	27	0	0	0	0	1,231	17	0	37	0	2,218	522
Wabash	0	0	0	0	0	0	0	0	0	0	6	0
Williamson	104	0	0	0	0	5	62	0	19	88	7,272	178
TOTALS	32,080	1,744	705	125	1,131	14,078	1,084	1,730	470	643	37,197	9,571

¹This table accounts for 100,558 acres when the total acreage should be 98,483 acres. Evidently, some acreages have been assigned two land uses. (Two additional categories involving additional acreages have not even been included in this table.)²Adapted from Haynes and Klimentz, 1975.³Water areas have been assigned several uses including about 65% of the acreage as recreational and 35% as consumptive.

Table 10-2

Observed Land Uses on Post-Low Lands Surface-Mined
for Coal in Illinois during the Period 1962-1971.2

County	Pasture	Hay	Row Crop	Orchards or Timber	Recreational Lands		Residential	Highways	Additional Mining	No Use Evident	Water Areas ³
					Organized	Unorganized					
Adams	0	0	0	0	0	0	0	0	0	51	0
Bureau	164	0	0	0	0	0	0	0	0	47	20
Fulton	3,226	1,977	139	0	37	17	0	22	600	8,422	1,171
Gallatin	18	0	0	0	0	0	0	0	57	1,198	0
Greene	0	0	0	0	0	0	0	0	0	6	0
Grundy	0	0	0	0	30	0	0	0	108	777	57
Jackson	432	0	0	0	0	0	0	0	92	268	27
Jefferson	0	0	0	0	0	0	0	0	292	21	2
Johnson	9	0	0	0	0	0	0	0	0	40	0
Kankakee	0	0	0	0	0	0	0	0	63	0	0
Knox	802	20	98	0	0	0	0	6	528	4,296	177
Menard	2	0	3	0	0	0	0	0	0	0	1
Peoria	2,767	0	0	0	0	0	0	5	667	1,325	190
Perry	1,820	0	0	0	0	0	0	0	139	5,257	17
Pope	0	0	0	0	0	0	0	0	0	26	0
Randolph	1,051	0	0	0	0	0	0	5	0	1,941	41
Saline	40	0	0	0	0	0	0	1	11	3,828	19
Schuyler	437	0	0	0	0	0	0	0	0	213	116
Stark	1,483	0	0	0	215	0	0	0	87	125	131
St. Clair	1,430	100	0	0	0	0	0	0	67	4,616	419
Vermilion	0	0	0	0	10	0	6	0	0	0	12
Wabash	0	0	0	0	0	0	0	0	378	1,061	4
Williamson	622	0	0	0	0	0	0	0	76	4,146	51
TOTALS	14,303	2,107	240	0	292	17	6	39	3,165	37,669	2,451

¹This table accounts for 60,289 acres when the total acreage should be 58,920. Evidently, some acreages have been assigned two land uses. (Two additional categories involving additional acreages have not even been included in this table.)

²Adapted from Haynes and Kilmsire, 1975.

³Water areas have been assigned several uses including about 70% of the acreage as recreational and 30% as consumptive.

Major Types of Vegetation Observed on Lands Surface-Mined for Coal in Illinois^{1, 2}

pre-1962 is known as pre-law, when Illinois was without any legislation controlling surface mine reclamation. 1962-1971 covered a period with mines, but not extensive requirements for regrading spoils.

2Adapted from Haynes and Klinestra, 1975.

Table 10-4

Early Historical Land Uses Before and After Mining
for Coal in Indiana,²

Acres

County	Total Acres in Survey	Pre-Mining Land Use		Post-Mining Land Use			
		Cropland ³	Other Uses	Forest ⁴ (Trees)	Pasture - Hay (grasses and Legumes)	Recreation	Un-used ⁵ (Barren)
Clay	18,295	14,015	4,280	17,280	250	1,900	660
Daviess	2,218	1,915	303	1,450	0	1,400	720
Fountain	380	310	70	300	0	0	60
Greene	18,200	5,200	13,000	5,725	2,925	3,800	0
Knox	2,825	2,525	300	325	350	70	1,775
Owen	2,690	1,850	840	1,550	100	1,100	1,140
Parke	443	180	263	210	0	21	227
Pike	16,104	7,604	8,500	3,385	0	333	12,485
Spencer	890	440	450	280	0	280	550
Sullivan	8,303	3,669	4,634	5,800	200	2,430	783
Vermillion	2,340	800	1,540	1,660	0	1,200	1,140
Vigo	7,727	6,305	1,422	3,500	525	5,530	1,670
Warrick	13,265	5,682	7,583	9,949	0	260	3,316
Other Counties	156	0	156	156	0	0	0
Total	93,836	50,495	43,341	51,363	4,350	18,324	24,685
% of Total	100%	53.8%	46.2%	54.7%	4.6%	19.5%	26.3%

¹This survey covers the period 1934 through 1959.²Source: Guernsey, 1960.³This category includes tilled row crop land, but does not state this explicitly.⁴This category does not distinguish between saplings and mature timber, which is probably scarce.⁵This category includes orphaned acres as well as unseeded acres which mining companies were allowing to leach prior to planting.

Table 10-5 Reclaimed Surface Mined Land in Indiana
According to County and Grading Class¹

County	Acres in Grading Class ²				
	Forest	Range	Pasture-Hay	Row Crop	Other
Clay	39.2	8.8	331.0	105.9	0
Daviess	0	0	41.4	0	0
Dubois	0	0	0	0	0
Fountain	16.7	13.0	0	0	0
Gibson	0	66.0	0	74.1	0
Greene	35.0	1,370.3	76.5	0	0
Knox	16.0	668.0	0	26.5	0
Martin	0	0	0	0	0
Owen	0	0	21.9	9.1	0
Parke	8.3	3.5	0	0	0
Perry	7.0	0	20.5	0	0
Pike	1,401.2	1,580.2	823.7	177.0	0
Spencer	28.0	141.2	554.2	99.6	0
Sullivan	472.0	1,865.0	1,168.0	249.0	0
Vermillion	2.8	3.0	318.3	1,353.0	0
Vigo	4.8	0	104.0	798.4	0
Warren	0	0	0	0	0
Warrick	165.0	5,579.7	534.9	1,967.0	39.5
Total	2,196.0	11,298.7	3,994.4	4,859.6	39.5

¹Indiana Department of Natural Resources, unpublished data

²Definition of Grading Classes (from Indiana Department of Natural Resources, undated, Standards for Surface Mine Grading):

Forest - slope steepness 33.3% maximum, pH of soil permitting establishment of vegetation

Range - slope steepness 33.3% maximum, pH of soil 5.5 or higher

Pasture - slope steepness 25% maximum, and for lengths not to exceed 100 ft; no permanent rocks greater than 6 inches diameter left exposed at surface; soil replacement

Row Crop - slope steepness 8% maximum, and for lengths not to exceed 125ft; no permanent rocks greater than 6 inches diameter left exposed at surface; soil replacement

Table 10-6 Reclaimed Surface-Mined Land in Ohio According to Permit Year and Type of Vegetation^{1, 2}

Period	Acres Affected	Acres Reclaimed as			Not Reclaimed ⁴
		Forest	Pasture-Hay	Non-vegetated ³	
1948 through 1952	45,270 (100%)	21,815 (48%)	19,409 (43%)	4,046 (9%)	0
1953 through 1957	52,120 (100%)	32,599 (62%)	17,483 (34%)	2,038 (4%)	0
1958 through 1962	50,655 (100%)	34,310 (68%)	15,138 (30%)	958 (2%)	249 (1%)
1963 through 1967	53,608 (100%)	32,955 (62%)	15,543 (29%)	708 (1%)	4,402 (8%)
1968 through 1969	23,044 (100%)	6,638 (29%)	3,315 (14%)	77 (1%)	23,044 (56%)
Total	224,697 (100%)	133,992 (60%)	70,888 (32%)	7,827 (3%)	11,990 (5%)

¹Source: Modified after Ohio Department of Natural Resources, 1973.

²Only acreages graded and planted or otherwise released from bond have been included.

³Includes water areas, paved or otherwise industrialized areas, re-affected areas, and areas released from bond as unplatable.

⁴Most of these acres were still being reclaimed when the report was issued.

Table 10-7

Early Trends in Revegetation of Surface-Mined Land
in Pennsylvania According to Year of Planting¹

<u>Period</u>	<u>Inferred Land Use (acres)</u>	
	<u>Woodlands</u> <u>(trees and shrubs)</u>	<u>Pasture-Hay</u> <u>(grasses and legumes)</u>
1954 through 1958	38,952 (85%)	6,854 (15%)
1959 through 1963	45,108 (82%)	9,635 (18%)
Total	84,060 (84%)	16,489 (16%)

¹Source: Davis et al., 1971.

Table 10-8

Land Uses Before and After Mining for Coal in Illinois:
Data Compiled from Approved Surface Mining Permits¹, 2, 3

Permit Year	Row Crop ⁴			Pasture (5 Water)			Forest			Wildlife			Recreation			Industrial		
	Before	After	Change	Before	After	Change	Before	After	Change	Before	After	Change	Before	After	Change	Before	After	Change
1972	3,854	0	-3,854	1,124	5,785	+4,661	1,329	396	-933	--	0	--	42.5	0	-42.5	0.8	168.5	+167.7
1973	2,782	1,682	-1,100	1,706	3,697	+1,991	1,124	234	-890	--	0	--	0	0	0	0	0	0
1974	2,481	1,936	-545	1,116	2,713	+1,597	1,387	300	-1,087	--	0	--	0	0	0	0	0	0
1975	3,547	2,836	-711	1,037	3,638	+2,601	2,081	51	-2,030	0	0	0	0	17	+17	36.2	159.4	+123.2
1976	9,074	9,350	+276	2,894	6,452	+3,558	5,249	982	-4,267	0	0	0	0	27	+27	18.6	425.2	+406.6
1977	1,513	2,325	+812	999	893	-106	1,253	262	-1,001	--	289	+289	--	0	--	9.0	15.7	+6.7
Totals	23,251	18,129	-5,145	8,876	23,178	+14,302	12,433	2,225	-10,208	0	289	+289	-42.5	44	+1.5	64.6	803.8	+739.2

¹The "before" columns refer to land use for a five-year period preceding application for a mining permit.

²The "after" columns refer to approved reclamation plans, not to realized land use.

³This information has been derived from the Illinois Department of Mines and Minerals, 1972-1977 Annual Reports, Surface-Mined Land Conservation and Reclamation).

⁴This category includes land to have level grading and land to have level grading plus dark topsoil replacement. The two categories are not distinguished because the latter has been implemented only recently, and is still quite small.

Table 10-9

Reclaimed Surface-Mined Land in Indiana According to
Permit Year and Grading Class¹

<u>Year</u>	<u>Acres in Grading Class²</u>			
	<u>Forest</u>	<u>Range</u>	<u>Pasture-Hay</u>	<u>Row Crop/Other</u>
1968	1,293	2,041	34	34
1969	543	3,002	36	36
1970	1,230	2,624	205	41
1971	865	2,318	668	79
1972	482	2,879	370	475
1973	236	2,740	558	1,063
1974	247	1,813	1,144	1,569
1975	391	1,472	1,472	1,813
1976	159	1,829	1,810	1,566

¹Indiana Department of Natural Resources, unpublished data

²Definition of Grading Classes (from Indiana Department of Natural Resources, undated, Standards for Surface Mine Grading):

Forest - slope steepness 33.3% maximum, pH of soil permitting establishment of vegetation

Range - slope steepness 33.3% maximum, pH of soil 5.5 or higher

Pasture - slope steepness 25% maximum, and for lengths not to exceed 100 ft.; no permanent rocks greater than 6 inches diameter left exposed at surface; soil replacement

Row Crop - slope steepness 8% maximum, and for lengths not to exceed 125 ft.; no permanent rocks greater than 6 inches diameter left exposed at surface; soil replacement

decreases from west to east (Illinois, 41% on old lands, 72% on intermediately aged lands; Ohio, 30% on intermediately aged lands; Pennsylvania, 16% on old and intermediately aged lands). At this level of resolution, regional variation in potential post-mining land use conforms with regional variation in existing land use (Figure 6-1).

Changes in Land Use Resulting from Surface Mining

Inferred changes in land use are given for Illinois in Table 10-3 and 10-8 for Indiana in Tables 10-4 and 10-9. In early years of surface mining and reclamation, the use of land for production of row crops such as corn and soybeans ceased and production did not return. Recent data indicate that the net change in row crop acreage has reversed in Illinois. The proportion of land returned to row crop capability has also been increasing in Indiana. Doyle (1976) emphasized negative aspects of surface mining row crop land in Illinois. His major contention is that present standards of reclamation will not restore the pre-mining agricultural productivity to surface-mined land. Grandt (1978) took the opposing view and presented the results of several studies in support of his view (see section on Agricultural Productivity to follow).

Table 24 indicates that recent trends in reclamation in Illinois result in a net loss of forest land. Table 10-9 suggests that forestation, once popular in Indiana, has become so unpopular that we can project a net loss of forest land in Indiana. Ashby et al. (1978) reviewed positive aspects of forestation. They conclude that after 30 years of growth, stands of trees of commercial valuable as timber have developed, especially in southern Illinois. In many parts of Illinois, forested areas satisfy a demand for recreational lands. Forested ungraded spoils have worked well in this capacity.

Reclamation of lands to range, pasture, or hay has been the recent preferred land use in Illinois and Indiana and has become the preferred land use in Ohio. Grandt (1971) and Reiss (1974) have reported favorably on this type of land use as it applies to overall coal company planning in the management of mined and unmined lands.

Rates of Recovery

Recovery can be defined by two standards: (1) legal standards for release of bond, and (2) achievement of the intended type of land use. Various state standards for revegetation require a permanent vegetative cover of 70-90% or, in the case of land to be tilled, continuous cropping. Tables 10-10 and 10-11 measure lag times between issuances of mining permits and releases of bonded acres (as reclaimed) in Illinois and Ohio. It must be recognized that mining, reclamation, inspection, and the paper work behind releasing the bond all

Table 10-10

Rates of Reclamation in Illinois as Defined
by Release of Bonded Acres^{1, 2}

<u>Years After Start of Permit Year</u>	<u>Number of Periods in Category (Sample Size)</u>	<u>Cumulative Fraction of Bond Released (%)</u>
<1	3	1.1
1	4	7.0
2	3	42.8
3	2	69.6
4	1	85.1

¹This table defines reclamation as legally approved and released from bond by the Illinois Department of Mines and Minerals, Land Reclamation Division. It is known that sometimes acres have been reclaimed and approved long before the responsible mining company has applied for release of bond (E. E. Filer, personal communication).

²This information has been derived from the Illinois Department of Mines and Minerals, 1973-1978 (1972-1977 Annual Reports, Surface Mined Land Construction and Reclamation).

Table 10-11

Rates of Reclamation in Ohio as Defined
by Release of Bonded Acres^{1, 2}Lag Times Between the Permit Year and Achievement of a Specified
Level of Reclamation

<u>Permit Year</u>	<u>The Greatest Apparent Expenditure of Effort (years)</u>	<u>>50% (years)</u>	<u>>75% (years)</u>
1957	2	2	4
1958	2	2	4
1959	2	3	3
1960	2	3	3
1960	3	3	4
1961	3	3	4
1962	3	3	4
1963	3	3	4
1964	3	3	4
1965	3	3	3
1965	4	4	4
1967	3	5	4
1967	4	5	6
1968	4	4	5

¹This Table defines reclamation as legally approved and released from bond by the Ohio Department of Natural Resources. It is possible that some acres were reclaimed at an earlier date, but that the coal companies lagged in application for release of bond.

²Source: Ohio Department of Natural Resources, 1973.

occur within the measured intervals. In both states, 50% and 75% of this combined activity appears to occur within three and four years, respectively.

From a perspective of land use, data on wide area achievement of objectives are lacking. Example rates are available as follows:

Quick cover crop such as wheat (occasionally with economic return) - one or two growing seasons following mining (e.g., 6-18 months) Taylor, 1978, Rich Sarver, personal communication).

Perennial grasses and legumes - 2 to 3 growing seasons following mining (1.5-2.5 years) (Anonymous, 1963, 1968).

Commercial forest - Christmas trees and pulpwood - 10 to 20 years (Bakeis, 1969; Ashby et al., 1978).

Commercial forest - pulpwood and at least a little saw timber - 29-35 years (Anonymous, 1963; Ashby et al., 1978).

Agricultural Productivity

Reclamation of former agricultural land to pre-mining agriculture use is a clear goal of the Federal Surface Mining Control Act of 1977 and the Illinois Surface-Mined Land Conservation and Reclamation Act of 1971. Quantitative, hard data include (1) productivity measurements (e.g., bushels per acre) of various row and forage crops following various applications of fertilizer and (2) gains in weight of livestock in relation to density and duration of grazing. A measure of success is the extent to which production on surface-mined land equals production on adjacent unmined land exhibiting the pre-mining soil type.

Grandt (1978) has concluded that row crop soils can be restored to their original condition of productivity for growth of corn and soybeans. He summarized several field studies conducted in Illinois. Preparation of surface mined areas for row crop production involved two general experiments. One provided a layer of topsoil, the other did not. The plots without topsoil had been mined several years prior to testing with crops, and thus had had the advantage weathering and conditioning from fallow vegetation. During crop test seasons chemical fertilizer was applied to both test plots. Corn yields reported by Grandt range from 60 bushels/acre in St. Clair County to 67-94 bushels/acre in Knox County with 75-85 bushels/acre constituting mid-range. In a three-year test of continuous corn planting in Knox County, production dropped from 94 to 68 bushels/acre. In the same study, corn planted on old surface-mined land provided with a fresh layer of topsoil yielded 121 bushels/acre without significant decline over the three-year period and without a significant difference from a control plot of corn on unmined land. Corn planted on recently mined land reclaimed with dark top-

soil replacement (Illinois SMC & RA, Rule 1104) yielded 69 bushels/acre. Grandt estimated that the plot had a pre-mining production capability of 50-91 bushels/acre depending on the intensity of crop management invested during farming. The censuses of agriculture have indicated that average corn production on all farms of Knox County ranges from 74-91 bushels/acre depending on census year (U.S. Department of Commerce, Bureau of Census, 1967, 1972, 1977).

It appears that drought may affect corn production on recently reclaimed land more severely than on unmined land (Caspall, in Doyle, 1976). However, this phenomenon appears to need further investigation.

The Metropolitan Sanitary District of Greater Chicago has developed a program, Prairie Plan, with dual goals of disposing of municipal sludge through land application and concurrent reclamation of surface-mined and eroded lands (Anonymous, 1974; Lynam, 1978). Economically profitable production of corn is one of their long-range goals, and several surface-mined fields are receiving gradual soil conditioning through application of liquid sludge. The majority of fields were stripped more than 20 years ago; however, some still required regrading of spoils in 1971. Table 10-12 presents results of test plantings of corn on several surface-mined fields. Some problems encountered have included poor water holding capacity (droughtiness and ponding) and stoniness, which restricts plowing. Treatment of spoils during mining predated any legal requirement for topsoil segregation and replacement. Relative to the Fulton County average production of 82 bushels per acre (calculated from U.S. Department of Commerce, Bureau of Census, 1967, 1972a, 1977a), the surface-mined fields appear to need more conditioning to increase productivity. However, the county-wide average yield may be misleading; much of the Prairie Plan acreage was originally forest soil and was therefore less productive than portions of the county covered with prairie soils (Lloyd Klindworth, personal communication). Grandt (1971), in summarizing reclamation for production of grains, stated that in most cases 10 years of forage (perennial grasses and legumes) should precede grain production on any continuing basis.

Wheat is good quick cover for freshly graded spoils as well as a potential crop. Taylor (1978) claimed that production on surface-mined lands in Indiana often exceeds 25 bushels per acre. Neale Teague (personal communication) gave the range as 15-40 bushels per acre. The average production for several Indiana coal counties (predominantly unmined land) was 37 bushels per acre in 1964, 35 in 1969, and 32 in 1974 (U.S. Department of Commerce, 1972b, 1977b). One surface-mined field in Fulton County, Illinois, yielded 30 bushels per acre one year and 10 bushels per acre the following year (Anonymous, 1963). Other plantings on old surface-mined lands have ranged from 8.3 to 20.1 bushels per acre (Hugh McMillan, personal communication). Wheat production in Fulton County averaged 31 (range 25-39) bushels per acre for the Agricultural Census of 1959 through 1974 (U.S. Department of Commerce; 1967, 1977). It appears that on occasion wheat can clear a profit and thus constitute an economically sound land use from a purely agricultural perspective.

Table 10-12

Experimental Production of Corn at Prairie Plan, Fulton County, Illinois¹

Field Number	Corn Production by Year (bushels per acre) ²						Level of Fertilization by Year (tons of dry sludge per acre) ³						
	1972	1973	1974	1975	1976	1977	1978	1972	1973	1974	1975	1976	1977
1						13.6				19.0	29.0	53.8	0.0
2				42.6			21.8			24.0	18.4	57.5	36.9
3	51.7	45.6	8.8	60.2		32.2		4.6	1.5	24.4	10.2	37.2	0.1
4							35.2		0.7	24.5	38.3	52.3	30.0
5						18.5			0.8	23.2	40.0	36.0	0.0
7		35.5			26.0				0.6	21.3	22.3	6.0	28.5
8						20.3			1.0	12.1	25.4	32.1	0.0
9	3.6		(6)					1.9	0.5	16.3	6.7	20.4	12.6
11						11.1				29.4	35.2	53.0	0.0
12							28.3			17.0	19.2	27.2	26.0
13										16.2	14.9	17.7	36.0
15 ⁴							30.9			29.1	30.1	59.4	40.7
17	3.6	32.9								19.2	20.9	15.0	37.4
25					38.2				2.4	9.7	29.0	0.0	50.2
26				41.1						27.3	12.4	43.9	48.3
28						11.2				17.2	36.6	42.4	0.0
30				23.4			31.6			20.1	19.4	45.0	56.1

¹Source: Hugh McMillan, unpublished data.

²Average yield for all harvests is 27 bushels per acre.

³Application of sludge: 1972 through 1975 by spray irrigation partly during the growing season.
1976, 1977 by direct incorporation into the soil during non-growing season.

⁴Same site as entry number 28, Table 10-13.

⁵Production throughout Fulton County was much below average during this year.

⁶Planted but not harvested.

Soybeans have been tested according to land reclaimed to the Illinois SMLC & RA Rule 1104 topsoil replacement. The estimated production was 19-25 bushels per acre, or intermediate between basic agricultural management (18 bushels per acre) and high level management (32 bushels per acre) (Grandt, 1978).

Reclamation to pasture is a popular trend in land use (Tables 10-1, 10-2, 10-8). Brief quantitative data on the quality of pasture are available for an unidentified site in Illinois (Grandt, 1971). Small lots of steers, some grazed on surface-mined pastures, showed equal gains in weight of about 1.3 pounds per day over a three-year period. This study did not state whether densities of grazing materials were the same on the mined and unmined lands. However, one may assume that the quality of forage actually consumed by the steers was similar. As part of a successful farming operation in Fulton County, Illinois, 350-450 young cattle have been grazed on surface-mined land for about five months annually before being placed in feed lots for finishing. Reference to pasturage of contour mixed benches is rare. One plan without published results called for spring to fall grazing of 80 cattle (cows with calves) on 55 acres of bench at Jellico, Tennessee, which is adjacent to Kentucky (Charton and Carr, 1977).

In summary, Grandt (1978) felt that pre-mining yields of grain and seed crops can be achieved on surface-mined lands with topsoil segregation and replacement. However, he concluded that the land should be planted with a legume-grass conditioning cover for a few years prior to row cropping. This cover should not be cut for hay during the first years of conditioning inasmuch as even hay and pasture productivity needs several years to develop thoroughly (Klimstra and Jewell, 1974).

There have been several special programs to facilitate reclamation. All states are able to perform reclamation with funds generated from bonds on delinquent mining operations. In addition, there are diverse programs within government and private industry which promote reclamation. An example of a governmental program is Pennsylvania's Operation Scarlift, created through bond issue in the mid-1960's. Scarlift reclaims orphaned lands. The Kentucky Reclamation Association (KRA) is a non-profit, self-financed private organization created by several coal companies. KRA gives technical advice and contracts to perform physical aspects of reclamation (Montgomery, 1965). Meadowlark Farms, the land management subsidiary of AMAX Coal Company, integrates reserve land, coal-less land, and surface-mined land into farm management units (Anonymous, 1963).

Visits to Field Sites

We conducted field studies in the spring and summer of 1978 to obtain first-hand knowledge of the status of surface-mined lands in the ORBES region. Through our site visits (Figure 10-1), we sought an array of the kinds and types of lands being mined as well as the forms of reclamation and the post-mining land uses of these lands.

By site-specific analysis, we developed insight into the ecological rates of recovery, both in terms of planted and volunteer vegetation. We were able to observe a wide variety of reclamation techniques and speculate on possible causes of either success or failure of the individual reclamation effort. Finally, in the overall analysis of site data, we attempted to identify regional trends in land use conversion, reclamation success, and many other factors associated with the surface mining of coal.

Selection of Sites: We selected study sites according to the following criteria:

1. Adequate coverage of the ORBES region was desirable.
2. Sites near high production areas were favored.
3. Sites near access roads were favored.
4. Strip mines on public land were favored because permission for study was not required.

During the course of our investigation, we found that public sites were limited, both in geographic dispersion and in era of mining activity. That is, none of the publically owned sites had been mined recently. Therefore, we turned to privately owned sites, which eventually constituted over half of our Field Sites.

Results: Tables 10-13 and 10-14 give the name, location method of mining (area vs. contour stripping), and dates of mining activity for 34 Field Sites, which are also located in Figure 10-1. One of these sites, Valley Coal (Site #29), is an active, medium sized mine. We also took somewhat more brief, though adequate, guided tours of two large mining operations: Old Ben Coal Company, Pike County Indiana, an area mining operation; and Falcon Coal Company, Breathitt County, Kentucky (E), an operation engaged in mountain-top removal.

Data on the topography, vegetation, and apparent land use were available from simple visual inspection. Other data, covering exact ownership, pre-mining land use, and any intended or planned post-mining land use, were much more scattered in availability. Records of our Field Site profiles became specialized beyond the scope of this report, and have been retained in open file at the Environmental Systems Application Center.

As for general trends, we saw how mining has progressed from small, localized operations with a moderate impact upon the topography to large, extensive operations which mine deeper, move more spoil, and can dramatically alter the natural topography. Both spoil grading and revegetation exhibit definite historical trends. Older operations have minimal grading of spoil

Table 10-13

STUDY SITES OF THE EASTERN INTERIOR BASIN

STATE County Name of Site	Site #	Type of Mining	Dates of Mining	Years Before 1980
ILLINOIS				
Fulton Flatt	1	area	1939-1969 ¹	11-14
Prairie Plan Field #15	2A	area	pre-1946 ²	>34
Prairie Plan Field #16	2B	area	pre-1946 ²	>34
Prairie Plan Field #24	2C	area	pre-1946 ²	>34
Prairie Plan Private	2D	area	pre-1946 ²	>34
Grundy Coal City Area Club	3	area	1945-1953 ³	28-35
Goose Lake Prairie State Park	4	area	1952 ³	28
Henry Atkinson	5	area	1950-1953 ⁴	27-30
Knox Sherwood Camp	6A	area	1936-1940 ^{5,6}	40-44
Sherwood Slurry Basin	6B	area	end ca. 1960 ⁷	ca. 20
Peoria Banner Mine	7	area	1959-1974 ⁸	6-21
Perry Pyramid State Park	8	area	1932-1938 ⁹	42-48
Streamline Mine	9	area	1973-1975 ¹⁰	5-7
Vermilion Harmattan Mine	10	area	ca. 1963-1970 ^{11, 12}	10-ca. 17
Kickapoo State Park	11	area	1925-1934 ^{12, 13}	46-55
INDIANA				
Pike Patoka State Fish Wildlife Area	12	area	pre-1943-1946 ¹⁴	34- >37
Sullivan Greene-Sullivan State Forest	13	area	pre-1938 ¹⁵	>42
Warrick Lynnville Park	14	area	1963-1964 ¹⁶	16-17
Enos	15	area	1967-1970 ¹⁷	10-13
KENTUCKY-WEST				
Hopkins Fox Run	16	area	pre-1952, post- 1963 ^{18, 19}	>28, <17
Mortons Gap	17	contour	pre-1952, pre-1963 ^{18, 20}	>28, <17
Richland	18	area	pre-1952 ²¹	>28
Muhlenberg Central City Area	19	area	post-1952, pre-1963 ²²	<28, >15
Ohio Rockport	20	area	pre-1952, pre-1963 ^{18, 23}	>28, >15

Footnotes for Study Sites of the Eastern Interior Basin (Table 10-13)

- 1 Kevin Brooks, Consolidation Coal Company, Norris, Illinois, personal communication.
- 2 Saint David, Illinois Quadrangle, 1948.
- 3 Tom Testa, Park Ranger, Goose Lake Prairie State Park; family member, Coal City Area Club, Coal City, Illinois, personal communication.
- 4 Carter et al., 1973.
- 5 Illinois Department of Mines and Minerals, 1937-1961 (Coal Reports).
- 6 Philip Christy, Reclamation Director, Midland Coal, Trivoli, Illinois, personal communication.
- 7 Charles Casey, Illinois Police Association, personal communication.
- 8 Illinois Department of Mines and Minerals, 1975.
- 9 Arata, 1959.
- 10 T. J. Dulley, Reclamation Officer, Southwestern Illinois Coal Corporation, Percy, Illinois, personal communication.
- 11 H. G. Perrine, Jr., Manager, Real Estate Service, AMAX Coal Company, Indianapolis, Indiana, personal communication.
- 12 David L. Reinertsen, Geologist and Acting Head of the Educational Extension Section, Illinois Geological Survey, Urbana, Illinois, personal communication.
- 13 Karr, 1968.
- 14 Delbert E. Parr, AMAX Coal Company, Indianapolis, Indiana, personal communication.
- 15 Linton, Indiana Quadrangle, 1940.
- 16 Amil Siebe, President, Lynnville Park Board, Lynnville, Indiana, personal communication.
- 17 Indiana Department of Natural Resources, Division of Reclamation, Strip Mine Permits.
- 18 Site has been restripped following a period of inactive mining.

Table 10-14

STUDY SITES OF THE APPALACHIAN BASIN

STATE County Name of Site	Site #	Type of Mining	Dates of Mining	Years Before 1980
KENTUCKY-EAST				
Bell				
Log Mountain East	21A	contour	1963-1964 ¹	16-17
Log Mountain West	21B	contour	1963-1964, 1970 ^{1,2}	16-17, 8
McCreary				
Beaver Creek East	22A	contour	1958 ³	22
Beaver Creek West	22B	contour	1955-1956 ³	24-25
Perry				
Hazard South	23A	contour	pre-1959-60 ⁴	>20
Hazard Northeast	23B	contour	pre-1959-60 ⁴	>20
OHIO				
Belmont				
Piedmont Reservoir	24	contour	pre-1960 ⁵	>20
Harrison				
Cadiz	25	area	pre-1958 ⁶	>22
Harrison County Reclamation Area	26	contour	pre-1960 ⁷	>20
Hocking				
Haydenville Lower	27A	contour	pre-1960, 1973 ^{2,8,9}	>20, 7
Haydenville Upper	27B	contour	ca. 1960 ^{8,9}	ca. 20
Minkers Run North	28A	contour	1952, 1966 ^{2,8}	28, 14
Minkers Run South	28B	contour	1952 ⁸	28
Valley Coal	29	area	1976-1977 ¹⁰	3-4
PENNSYLVANIA				
Butler				
Bear Run	30A	contour	1959 ¹¹	21
Lakeview	30B	contour	1955-1962 ¹¹	18-25
Sunken Garden	30C	contour	1954-1958 ¹¹	22-26
WEST VIRGINIA				
Fayette				
Babcock St. Park	31	contour	ca. 1947 ¹²	ca. 33
Mercer				
Windmill Gap	32	contour	1965 ^{13, 14}	13
Randolph				
Alpena Gap South	33A	contour	1957-1958 ¹⁵	21-22
Alpena Gap North	33B	contour	1957-1958 ¹⁶	21-22
Tucker				
Blackwater Falls State Park	34	contour	1948 ¹⁷	32

Footnotes for Study Sites of the Appalachian Basin (Table 10-14)

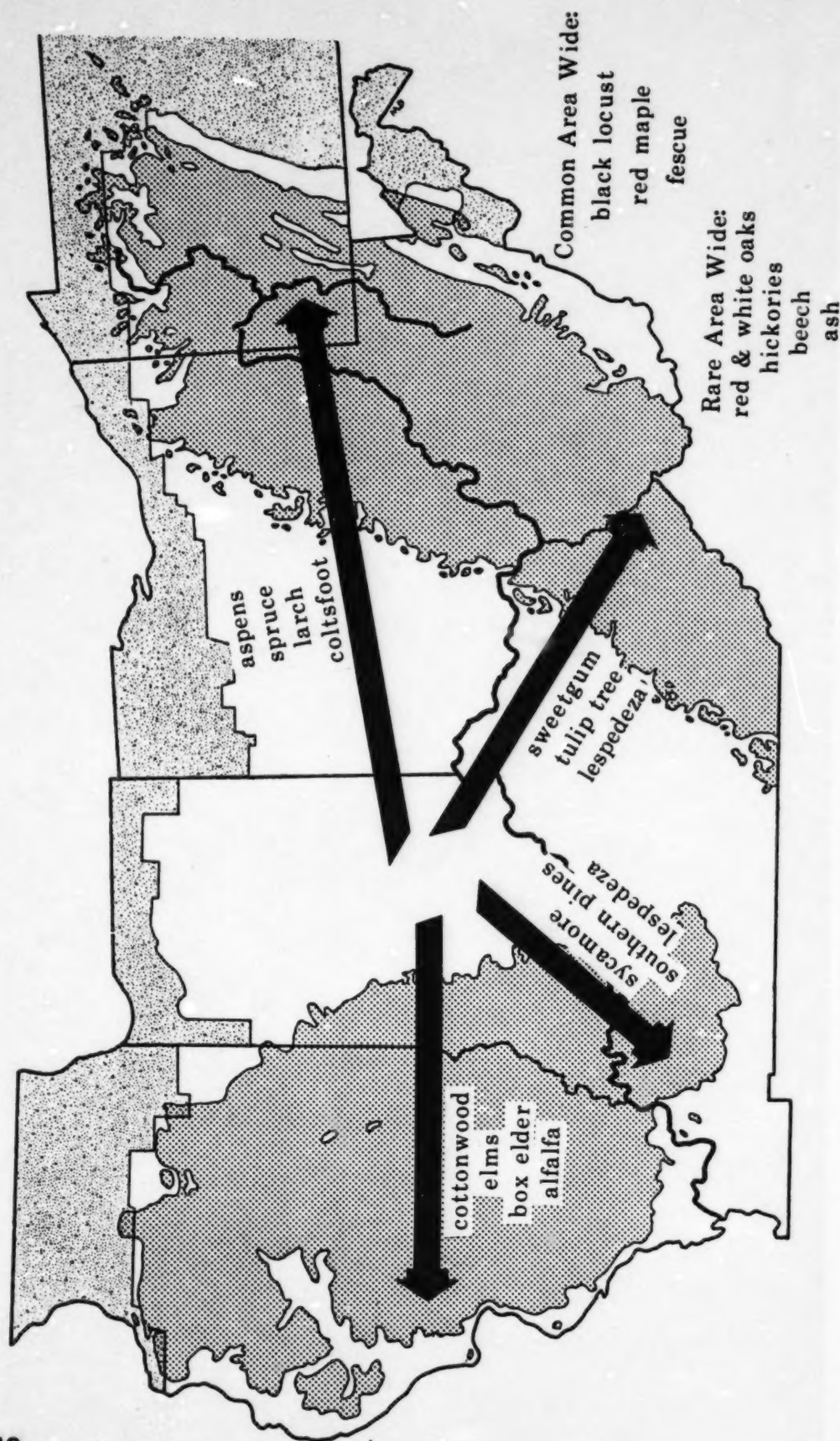
- 1 Willis G. Vogel; U. S. Department of Agriculture, Forest Service, Berea, Kentucky; personal communication.
- 2 Site has been restripped following a period of inactive mining.
- 3 Musser, 1963.
- 4 Rev. Drew Martin, Big Creek Church (Adjacent to Site), personal communication.
- 5 Piedmont, Ohio Quadrangle, 1961.
- 6 Harrisville, Ohio Quadrangle, 1960.
- 7 Jewett, Ohio Quadrangle, 1961.
- 8 R. F. Elisar, District Ranger, Wayne National Forest, Athens, Ohio, personal communication.
- 9 Union Furnace, Ohio Quadrangle, 1961.
- 10 Rick Sarver, Director of Reclamation, Mac Energy Division, Valley Coal, Coonville, Ohio, personal communication.
- 11 Eugene Frund, Chief of Mineral Section, Bureau of Forestry, Pennsylvania Department of Environmental Resources, Harrisburg, Pennsylvania, personal communication.
- 12 Lacy B. Aliff, Jr., Assistant Land Manager, Westmoreland Coal Company, Tams, West Virginia.
- 13 C. L. Helmick, Chief Engineer, Pocahontas Land Corporation, Bluefield, West Virginia, personal communication.
- 14 Crumpler, West Virginia Quadrangle, 1967.
- 15 Dr. Manley, Forest Geologist, Monongahela National Forest, Elkins, West Virginia, personal communication.
- 16 Reclaimed as orphaned land by West Virginia Department of Natural Resources.
- 17 Anthony P. Mollish, Operations Manager, Timberlands Division, Westvaco, Rupert, West Virginia, personal communication.

- 19 Saint Charles, Kentucky Quadrangles, 1954 and 1963.
- 20 Nortonville, Kentucky Quadrangles, 1953 and 1963.
- 21 Madisonville West, Kentucky Quadrangle, 1954.
- 22 Central City West, Kentucky Quadrangles, 1953 and 1963.
- 23 Paradise, Kentucky Quadrangles, 1954 and 1963.

OHIO RIVER BASIN ENERGY STUDY PHASE II

Figure 10-2

COMMON REGIONAL SPECIES



and extensive natural revegetation. Contemporary operations grade spoil to nearly original contour and extensively replant the mined area (with varying degrees of success). The kinds of species planted have also changed through time. Originally, trees were planted extensively; now forage species are most commonly sown. Post-mining land use has also changed, as is reflected in planted species, from forest-related uses to pasture.

An initial purpose of the field studies was to assess the regional trends in strip mining, reclamation, and land use. Although we were able to observe some regional trends, we based these observations on only the 34 sites spread throughout the states; thus, we present our conclusions with reservation.

Some regional trends are evident, however, the dominant method of mining is obviously regional. Volunteer vegetation appears to have a regional distribution and, to a lesser degree, so does planted vegetation.

A capsule digest of regional abundances of important vegetation is given in Figure 10-2. This diagram places the observer on the coal-free portion of the Cincinnati Geologic Arch and allows the observer to move as shown by arrows. Expectations of finding listed plants are high in regions flagged by arrows, and lower to unlikely elsewhere.

Through our field studies we were impressed by the potential of surface-mined lands. Although once considered worthless, these lands are not worthless. The potential exists for recreation, wildlife habitat, water supply, forestry, commercial or residential development, or pasture. However, the gob and slurry areas, which are relatively small in acreage and nearly barren, present a challenge to any positive form of land use.

Reclamation in the Future

Pursuant to implementation of the Permanent Regulatory Program of the Surface Mining Control and Reclamation Act of 1977 (SMCRA) both regrading and revegetation practices throughout the ORBES region will become more uniform than they were in the past. The following discussion outlines what variation will remain and what variation formerly characteristic of surface-mined areas will be excluded.

Slope and parent soil conditions will insure that differences remain between reclaimed lands in the Appalachian Basin and the Eastern Interior Basin. Most reclaimed lands in the Appalachian Basin will have sloping surfaces graded to meet the contours of the original hilly lands. The soils are shallow and will provide only a thin layer of material to spread over the graded spoils. Premining conditions in the Eastern Interior Basin tend to provide deep soils and a level landscape. Mountaintop removal can create isolated areas of level land in the Appalachian Basin; however, the cover of topsoil will still be formed from the shallow forest soils of the region.

During the first few years of reclamation, vegetation of surface-mined lands throughout the ORBES region will be more uniform than later on. Operators are required to plant quick cover species for the first few growing seasons. The mixture of seeds used in this planting usually includes grasses and legumes. An annual grass, such as wheat, dominates the ground cover during the first growing season. By winter an understory of clover, birds-foot trefoil, orchard grass and fescue commonly replaces the wheat, which has died back. Some operators favor planting seed mixtures including numerous, possibly dozens, of species. The operators assume that some seeds will be more adaptive than others to minor differences in soils, and that as a whole the best species for each local soil condition will have its chance for growth (Hillis Everidge, personal communication). Long term vegetation on many lands, which will be used for pasture and hay, can develop from this initial planting with additional fertilization, or with a later broadcast of seed and fertilizer as enhancement. In the Eastern Interior Basin large acreages will be returned to row crop production during the third to fifth growing season following mining. In the Appalachian Basin surface owners (such as the Wayne National Forest, Ohio) may plant trees. Other lands may experience natural replacement of the planted grasses and legumes with native brush and young trees. No lands reclaimed between 1976 and 2000 will be producing saw timber by the year 2000, and only the most prosperous plantings of hybrid poplars may be producing pulpwood.

Federal Regulations expect regional differences in final land use, defined as that land use which will release surface mine operators from further responsibility for a given tract of land. Without attempting exact quantification, the following post-mining land uses should be important in the following states and regions:

Prime Farmland row crop: Illinois, Indiana

Other agricultural land, row crop and pasture/hay: Ohio, Kentucky-West, Indiana, Illinois

Pasture/hay, commercial forestry: Ohio, Pennsylvania, West Virginia

Mountaintop Removal agricultural land, pasture/hay: Kentucky-East, West Virginia

Steep Slope commercial/forest and recreational wildlife woodlands: Kentucky-East, West Virginia

These land use categories and locations reflect existing land uses and options to institute higher categories of land use as permitted by law.

Given the economic pressures discussed in Chapter 4, the following net or directional shifts in land use are probable:

Illinois:	forest and pasture to row crop, forest to pasture and hay meadow;
Indiana:	forest to pasture and hay meadow, pasture and hay meadow to row crop;
Kentucky-West:	forest to pasture and hay meadow;
Kentucky-East:	commercial forest to recreational lands, pasture and hay meadow;
Ohio:	commercial forest to pasture and hay meadow;
Pennsylvania:	commercial forest to pasture and hay meadow;
West Virginia:	commercial forest to recreational wildlife lands, pasture and hay meadow

In this list, commercial forest may occur on very steep slopes prior to mining. After mining these lands may be recommended for wildlife on the basis of SCS standards for Class 8 soils (e.g., West Virginia State Conservation Needs Inventory Committee, 1970).

Christy et al. (1979) have provided evidence that surface mining and reclamation is converting forest land into row crop and pasture in Illinois. We have observed where open fields have replaced forest following mountaintop removal.

We can argue that some of the unnatural features of old mined lands have enhanced land use locally, or at least have permitted local variation in land use which has improved local quality of life. Clear benefits can develop from the end cut lakes, ponds and wetlands. These areas can provide recreational and even residential use where lakes are scarce (Ashby et al., 1978). Wildlife utilization of surface mine lakes and ponds is well documented (Ashby et al., 1978; Samuel et al., 1978). For example, in mountainous Appalachia, contour cut ponds can provide still water habitat for fish and semi-aquatic animals and drinking water for upland wildlife. The ridge and valley aspects of ungraded area mined lands have recreational value in regions where the land is flat and monotonous. Illinois has developed two state parks (Kickapoo, Pyramid) from these lands. Although seldom mentioned, high walls can become habitat for rock-crevice wildlife which normally depends on natural outcrops. Grading to original topography will prevent development of end cut lakes, ridge and valley topography, and rock outcrops.

SUMMARY

- A. In the ORBES region, more than 1,600,000 acres (2,500 square miles) have been affected by surface mining for coal. About 400,000 of these acres are at least 16 years old or only partially reclaimed, or both. In the Eastern Interior Basin the tonnage yield per acre of disturbed land is twice or nearly twice that of the Appalachian Basin.
- B. Strippable reserves constitute about 17 percent of the total reserve base in the ORBES region. The tonnage produced by surface mining to date is only 18 percent of the total strippable reserves. Historically, surface mine production grew gradually until the 1940's, when it increased rapidly, then leveled off at a higher volume of production. Rapid growth again occurred during the 1960's and 1970's. Today, extensive surface-mine production is occurring throughout the ORBES coal fields, although intensity of the activities in relation to availability of coal varies greatly between counties and states.
- C. Agriculture is an important land use in the Eastern Interior Basin, while forestry or the timber reserve is relatively unimportant. The converse is true of the Appalachian Basin. The greatest potential for conflicts between agricultural and surface mining occurs in Illinois. For forestry, the potential for conflict is greatest in central and southern West Virginia.
- D. The influences of legislation on post-mining land use are relatively recent, because stringent laws regulating reclamation are less than 20 years old. The long history of need for strong legislation is evident from the status of reclamation. The Soil Conservation Service has indicated that 60 percent of all acreage ever mined still needs reclamation. However, certain states show a good record of reclamation within the existing state law.
- E. The current round of political negotiations by companies, states, and environmental groups clearly indicates that the regulations are not yet settled. The ORBES states differ in their attitudes toward regulation; each will probably elect to regulate its own surface mining industry within the federal guidelines.

- F. Old surface-mined lands have rough topography, barren areas, and diverse vegetation where plants survive. The topography is a result of historical patterns of spoils placement during mining and the absence of regrading afterward. Lack of planning concerning toxic spoils, lack of knowledge about hardy species of plants, and natural invasion of indigenous species have contributed to irregular patterns of vegetation. In the ORBES region, trees and other woody plants predominate. Contemporary mining operations grade spoil to nearly original contour and extensively replant the mined area (with varying degrees of success). Forage species are most commonly sown. Post-mining land use has changed, as is reflected in planted species, from forest-related uses to pasture.
- G. A compilation of observed post-mining land use was available for Illinois only. Much of this land is being used for pasture and range of livestock, but even more is not being used for anything. Recreational use of forested lands with water areas may be the highest intensity both in terms of population density and investment in real estate. We have observed on declarations of intended land use that reclamation to tillable cropland has become increasingly important in Illinois and Indiana during the 1970's. Judging from records on bonded lands, reclamation to any form of enduring land use probably takes more than two years following mining.
- H. Contrasting the two ORBES Coal Basins, surface mining in the Appalachian Basin causes greater environmental disruption because of higher acreage to tonnage relationships required for production, the longer time required for regrowth of forests in contrast to meadow, or the abandonment of native forest for meadow/pasture as an endpoint of reclamation. These changes are not equated to socioeconomic gains or losses.
- I. The ORBES scenarios predict that surface mining of coal for all purposes will disturb more land between 1976 and 2000 than has been disturbed since surface mining began. Local power plant demand will account for over a third of this disturbance. Individual scenarios do not vary appreciably in their impacts for two reasons: 1) the difference between high and low coal demands is only 15% of the average demand for ORBES power plant needs and 25% of total production needs and 2) the coal supply, though widely dispersed in ORBES geographically, is relatively stationary in terms of exploitation. Thus, the variation in demand becomes a small increment spread over a large area.

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Note: Documentations of legal analyses are located with Tables 3-3 and 3-4, and at the end of Chapter 4.

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